



**DICTIONARY OF  
AERONAUTICAL TERMS**

**PUBLISHED BY**  
**PITMAN**

**Bennett's Complete Air Navigator**

Covering the Syllabus for the First-class Air Navigator's Licence.

By D. C. T. BENNETT, C.B., C.B.E., D.S.O.,  
F.R.Ae.S., F.R.Met.S. 15s. net.

**Wings in Motion**

A Practical Study of Flight.

By E. T. JAGGER, A.M.I.Mech.E. 7s. 6d. net.

**Aircraft Radio (Air Transport Series)**

With a Chapter on Airport and Airway Lighting.

By D. HAY SURGEONER, A.F.R.Ae.S. 15s. net.

**Aero Engines**

For Pilots and Ground Engineers.

By O. CAUDWELL. 5s. net.

**Rapid Navigation Tables**

By W. MYERSCOUGH and W. HAMILTON.  
10s. 6d. net.

**Maps and Elementary Meteorology for Airmen**

By W. MYERSCOUGH. 3s. 6d. net.

*Send for Pitman's Aeronautical  
Catalogue, post free, from*

**39-41 PARKER STREET, KINGSWAY, W.C.2**

# DICTIONARY OF AERONAUTICAL TERMS

BY

GROUP CAPTAIN H. NELSON, C.B.E., R.A.F.



LONDON

SIR ISAAC PITMAN & SONS, LTD.

1946

THE BOOK STALL,  
Taj Mahal Hotel,



SIR ISAAC PITMAN & SONS, LTD.  
PITMAN HOUSE, PARKER STREET, KINGSWAY, LONDON, W.C.2  
THE PITMAN PRESS, BATH  
PITMAN HOUSE, LITTLE COLLINS STREET, MELBOURNE  
UNITEERS BUILDING, RIVER VALLEY ROAD, SINGAPORE  
27 BECKETTS BUILDINGS, PRESIDENT STREET, JOHANNESBURG

ASSOCIATED COMPANIES  
PITMAN PUBLISHING CORPORATION  
2 WEST 45TH STREET, NEW YORK  
205 WEST MONROE STREET, CHICAGO  
SIR ISAAC PITMAN & SONS (CANADA), LTD.  
(INCORPORATING THE COMMERCIAL TEXT BOOK COMPANY)  
PITMAN HOUSE, 381-383 CHURCH STREET, TORONTO



THIS BOOK IS PRODUCED IN  
COMPLETE CONFORMITY WITH THE  
AUTHORIZED ECONOMY STANDARDS

---

MADE IN GREAT BRITAIN AT THE PITMAN PRESS, BATH  
D5—(A.139)

## PREFACE

DURING my connexion with aviation, both as a technician and pilot, over the past thirty-two years, I have continually met new technical terms and alteration in meaning of existing terms. This is inevitable with a young, growing science and I therefore collected, over this period, explanations of various terms with which I had to deal. It is possible that many of these terms will have slight alterations of meaning over the coming years, and I hope it will be possible not only to keep this Dictionary up to date, but to add to it considerably as new terms come into use over the very wide field of aeronautics. Aeronautics covers many subjects, such as engineering, navigation, meteorology, etc.

I wish to thank Wing Commanders A. G. Abel, A. Gillespie, and J. B. Stoneman for their assistance in checking these terms, and in particular the patience and help of my wife who has continually encouraged me to persevere with the task.

H. NELSON,  
GROUP CAPTAIN,  
R.A.F.



# DICTIONARY OF AERONAUTICAL TERMS

## A

**A.** Symbol used in aeronautical engineering to denote the aspect ratio of an aerofoil.

In the Royal Air Force it also indicates an armament specialist officer.

**A.A.** See **ANTI-AIRCRAFT**.

**A.A.F.** See **AUXILIARY AIR FORCE**.

**Abaft.** A nautical term used to indicate the position of an object nearer to the stern of a ship than some other object. E.g. "An aeroplane is abaft the funnel."

**Abeam.** At right angles to the fore and aft lines and viewed from amidships.

**Abel Test.** This refers to the method of testing petroleum to ascertain the temperature at which an inflammable vapour is formed, by using an apparatus devised by Sir Frederick Abel (1827-1902), the construction and use of which are fully described in Schedule I of the Petroleum Act, 1879.

The temperature at which an inflammable vapour is formed is known as the "flash point" of the oil, which information is important in connexion with the storage of the more volatile spirits.

Essentially the test consists of placing a measured quantity of the oil into a closed vessel which is surrounded by a water jacket. Heat is applied slowly, and at every few degrees rise in temperature a small flame is introduced to the air and vapour space above the surface of the oil. The temperature at which the vapour ignites is referred to as

the flash point. The Abel test indicates the "closed flash point" of the oil.

**Abney Level.** See **ADJUSTABLE LEVEL**.

**Abnormal Spin.** A spin which must be started by severe use of the controls and from which recovery to normal flight generally requires the use of opposite controls.

**Abrasives.** Materials used for grinding, scouring, and polishing. High-grade abrasives such as emery or corundum are natural materials, alumina and carborundum are artificial. The latter are generally manufactured by an electrical process. Low-grade abrasives are crushed quartz for sandpaper, pumice powder or diatomaceous earth for scouring materials. Grindstones for the sharpening of tools are made from millstone grit. Abrasives are essential for many operations in the manufacture of aero engines and airframe parts. Abrasives are particularly suitable as a means of finishing a piece of metal which must be to close limits and where the final operation requires the removal of a microscopically thin layer of metal. The roughness of an abrasive is known as its grain.

**Abreast of the Beam.** See **ABEAM**.

**Abscissa.** A horizontal reference line on a graph or chart.

**Absolute Altimeter.** An instrument which indicates the absolute altitude, that is, the vertical height above a given datum. One type transmits radio-waves from the aircraft which are reflected back

from the earth. The time taken is converted into feet and indicated on a dial.

**Absolute Ceiling.** The height at which in standard atmosphere the rate of climb of an aircraft would be zero under specified conditions.

See also SERVICE CEILING.

**Absolute Humidity.** The amount of water vapour present in a unit volume of air. This can be determined by passing a known quantity of air through a container fitted with an absorbing substance which removes all the moisture, the air being weighed before and after the moisture absorption.

**A.C.** See AIRCRAFTMAN.

**"A" Certificate (Glider).** A certificate issued by the Royal Aero Club of the United Kingdom under conditions laid down by the International Aeronautical Federation. There are three classes—A, B, and C—the last being the highest category. Candidates for the "A" certificate are required to carry out, under observation, certain tests in all of which the candidate must be alone in the glider. The tests consist of a flight of at least 30 seconds' duration followed by a normal landing. A candidate must have made at least 12 glides, or, alternatively, must hold an aeroplane pilot's licence.

**Acceleration.** When a body is moving with a varying velocity it is said to have an acceleration.

The most common example is a body falling freely under the action of gravity, in which case its speed is constantly increasing; e.g. when a body has been falling for two seconds its velocity will be approximately 64 ft. per sec., whilst after ten seconds the velocity will be 320 ft. per sec.

Acceleration =  $\frac{\text{Change of velocity}}{\text{Time}}$

the units being generally expressed in ft. per sec. per sec.

Using the figures quoted in the above example, we get

$$a = \frac{V_1 - V_2}{t} = \frac{320 - 64}{8} = 32 \text{ ft. per sec.}^2$$

Acceleration may be either positive or negative, i.e. in the former case the velocity would be increasing and in the latter decreasing.

When applied to rotating bodies the angular velocity is measured in radians per second, and the acceleration in radians per second per second.

**Accelerator Pump.** A device incorporated in modern aero-engine carburettors to provide enrichment of the fuel/air mixture passing to the engine during the period of acceleration.

For a variety of reasons, when the throttle is suddenly opened by the pilot a momentarily weak mixture reaches the engine cylinders, and this prevents the engine from responding immediately to the conditions brought about by the new position of the throttle; consequently some means of enriching the mixture under these conditions is necessary. In its simplest form the accelerator pump consists of a cylindrical plunger connected by linkage to the throttle lever. Any forward movement of the lever causes the plunger to be forced down and fuel to be injected through a special duct into the mixture passing through the carburettor, thus enriching it temporarily.

The latest type used for supercharged engines has a second plunger of larger diameter placed axially below the upper plunger. In this case, the movement of the first plunger delivers fuel as already described, but also compresses a spring positioned above the lower plunger. The energy in the spring forces the second plunger downwards and an additional supply of fuel is delivered through a

calibrated jet for a period of three seconds, thus maintaining the enrichment after the throttle lever has come to rest. This latter is referred to as the delayed action type.

**Accelerometer.** An instrument used to measure acceleration in a defined direction. It may be of the following types—indicating, maximum reading, or recording accelerometer.

In principle it consists of a springy cantilever carrying a weight at the free end. If the body to which the instrument is attached accelerates, it will cause the cantilever to deflect, the amount of deflection being proportional to the magnitude of the acceleration. By a suitable mechanism this deflection may be used to indicate the acceleration on a calibrated scale.

**Accumulators.** An accumulator is a device for storing energy, the most common forms being the hydraulic accumulator and the electric accumulator or secondary cell.

*The hydraulic accumulator.* In its simplest form this consists of a large cylinder placed with its axis vertical and fitted with a piston. The piston is stationary, and fluid forced into the cylinder above it causes the latter to rise. The cylinder is loaded with weights so that a predetermined fluid pressure will be required to cause it to move. Thus when the cylinder is filled with fluid under pressure a large reservoir of energy is available to return to the hydraulic system to which it is connected. In aircraft hydraulic systems the cylinder is fixed and the piston moves under oil pressure fed in below it against compressed air on the top side. The force on the top of the piston due to the compressed air fulfils a similar function to that of the weights referred to above. When the hydraulic jacks are in

operation a larger quantity of fluid is circulating in the system, and it may happen that the capacity of the pumps above is insufficient to maintain the operating pressure. In such a case a hydraulic accumulator is incorporated to make up the deficiency and thus allow the pressure to be sustained.

*The electric accumulator.* For convenience this may be regarded as a device which is capable of storing electrical energy. It functions by converting electrical energy into chemical energy or vice versa, according to the well-known laws of electrolysis.

There are two classes of accumulator, viz. the "lead-acid" and the "alkaline" types. The lead-acid cell consists of a number of plates (connected alternately to one of two bars at their top edges), which are prevented from coming into contact by suitable "separators," and which are immersed in a liquid called the electrolyte. One set of plates is connected to the external positive terminal and the other to the negative. The composition of the plates varies, but commonly they consist of a lead grid, the interstices of which are filled with a paste of lead oxide, whilst the electrolyte is dilute sulphuric acid.

When the positive terminal is connected to the positive lead from a D.C. supply and the negative terminal to the negative lead, an electric current will flow through the plates and electrolyte, setting up a chemical action which results in the formation of lead peroxide at the positive plates and spongy lead at the negative plates. If the charging current is removed and the terminals of the accumulator connected to an external circuit an electric current will flow in a reverse direction to the charging current owing to the chemical action between the plates and electrolyte

being reversed. Thus when discharged the plates and electrolyte return to their original condition, and the whole process described above may be repeated. The alkaline accumulator is similar in action to the lead-acid kind, but in this type the electrolyte is an alkaline solution, usually potassium hydroxide, and the plates nickel oxide for the positive and iron oxide for the negative.

When charged, a lead-acid cell has an e.m.f. of 2.2 volts, whilst that of the alkaline cell is about 1.46 volts.

**Ace.** A French or American pilot who had five confirmed air victories during the war 1914-18 received the title of "Ace." A German pilot had to obtain ten victories for this distinction. No such classification was adopted by the British.

**Acetate Dope.** A dope manufactured from cellulose and acetic acid. It is inflammable.

**Acetone.** Acetone is a colourless liquid, freely soluble in water, alcohol or ether. It is a useful solvent for organic substances, and is used for the removal of dope from aircraft. Its chemical formula is  $(CH_3)_2CO$ .

In addition to its use as a solvent it is required in considerable quantities for commercial purposes, being used as a chemical reagent in the manufacture of chloroform, iodoform, rubber substitutes, etc. Acetylene is dissolved in acetone for convenience of transport and general use, the resulting solution of acetylene and acetone being absorbed by a porous material and packed in steel cylinders under pressure.

**Acetylene.** A colourless gas which is slightly lighter than air. Its chemical formula is  $C_2H_2$ , and it is manufactured by the action of water on calcium carbide. The gas is used in conjunction with oxygen for the welding of metals, the

temperature of the flame being about  $3500^{\circ}C$ . The two systems of oxy-acetylene welding generally employed are high-pressure and low-pressure systems. In the high-pressure system each gas is drawn from separate cylinders (see ACETONE) and mixed in a high-pressure blowpipe. In the low-pressure system, the oxygen is drawn from a cylinder, but the acetylene is supplied under low pressure from a special generator. In this case the blowpipe is constructed so that the high-pressure oxygen draws the low-pressure acetylene from the generator, and both gases combine at the blowpipe nozzle. In addition to the welding of metals, oxy-acetylene is used for cutting through plates and bars of most metals.

Copper acetylide is an explosive mixture, and for this reason acetylene should not be stored in copper containers or passed through copper pipes.

**Acidometer.** An instrument used for measuring the specific gravity of acids employed in accumulators.

See also HYDROMETER.

**A.C. Mains.** Power station supply mains which deliver an alternating current.

**Acorn.** A device of streamline shape fitted at the intersections of cross-bracing wires or other wires in close proximity to hold them apart, thus preventing abrasion.

**Acrobatics.** See AEROBATICS.

**Acrylic and Vinyl.** These are plastics possessing the property of glass-like clearness. They are derived from acetylene and are extensively used in the aircraft industry for windscreens, transparent hoods, etc.

**Actuating Gear.** Hand-controlled mechanism provided on aircraft for altering the angle of attack of the tail plane or fin to adjust the trim in flight.

**A.C.W.** See AIRCRAFTWOMAN.

**Adaptor.** A component fitted to a complete unit which enables the latter to perform additional duties.

**Adastral House.** The building, originally De Keyzers Royal Hotel, in which part of the Air Ministry staff is domiciled.

The name is derived from the original motto of the R.F.C. "Ad astra."

The full address is—

Adastral House, Kingsway, London, W.C.2.

**Adiabatic.** When a gas is compressed its temperature rises according to well-known thermodynamic laws, and, conversely, when expanded, the temperature falls. If the material of the cylinder in which the gas is contained is a perfect non-conductor of heat (also the piston), then when work is done on the gas no interchange of heat takes place between the gas and cylinder walls, etc. Consequently, no heat is lost to any external source. Under such conditions the compression or expansion of the gas is said to be adiabatic. In aero engines, owing to the high piston speed, the gases are in contact with the heat-conducting surfaces for such a short time that the expansion and compression approximate closely to adiabatic conditions.

For adiabatic changes the relation between the pressure and volume of the gas is given by the equation  $PV^\gamma = \text{constant}$ , where  $\gamma$  is the ratio of the specific heats of the gas at constant pressure and at constant volume. For dry air,  $\gamma = 1.402$ .

**Adiabatic Lapse Rate, Dry.** See DRY ADIABATIC LAPSE RATE.

**Adiabatic Lapse Rate, Saturated.** See SATURATED ADIABATIC LAPSE RATE.

**Adjustable Level.** This is a type of clinometer used for the adjustment of surfaces to a small angle with the horizontal or to measure the angle which a given surface

makes with the horizontal. The adjustable level is graduated to measure angles from  $0^\circ$  to  $10^\circ$  and consists of a metal base with a hollow pedestal at one end. Carried in the metal base is a spirit-level pivoted at one end and moved vertically by a graduated screw, one turn of which tilts the level one degree. The head of this screw is divided into twelve equal parts, hence each division will represent an angular movement of five minutes.

This level may be used for checking incidence and dihedral angles in the case of aircraft.

**Adjustable Pitch Propeller.** A propeller whose blade-pitch can be adjusted on the ground before flight, but not during flight.

**Admittance.** The reciprocal of impedance. The admittance is therefore expressed as

$$\text{Admittance} = \frac{1}{\text{Impedance}}$$

and is measured in ohms.

**Aerial.** This is an essential part of a radio transmitting or receiving apparatus, and is a device to transmit or receive wireless waves. It is sometimes referred to as an antenna, and consists of a length of wire forming part of an oscillatory circuit.

See also COLLAPSIBLE AERIAL; FIXED AERIAL; TRAILING AERIAL.

**Aerial Derby.** A race organized in 1912 and held annually until 1923, when it was replaced by the King's Cup Air race.

Year	Pilot	Aeroplane	Engine
1912	T. O. M. Sopwith	Bleriot	70 Gnome
		58.5 m.p.h.	
1913	G. Hamel	Morane	80 Gnome
		78.18 m.p.h.	
1914	W. L. Brock	Morane	80 Gnome
		72.15 m.p.h.	
1919	G. W. Gathergood	D.H.4	450 Napier
		129.38 m.p.h.	
1920	F. T. Courtney	Martin-syde	300 Hispano Suiza
		153.45 m.p.h.	
1921	J. H. James	Gloster	450 Napier
		163.34 m.p.h.	
1922	J. H. James	Gloster	450 Napier
		176.48 m.p.h.	
1923	L. Carter	Gloster	450 Napier
		192.4 m.p.h.	



**Aerial Weight.** A small weight which is attached to the end of a trailing aerial.

**Aero Club.** See ROYAL AERO CLUB.

**Aero Engine.** An engine which is used to provide the motive power for an aircraft. Aero engines are generally operated either on the Otto, or four-stroke, cycle or on the compression-ignition cycle, and may be divided into two classes, viz. liquid-cooled engines and air-cooled engines. The former type normally consists of two or more banks of cylinders each arranged in line along the crankshaft, whilst the latter, with only one or two exceptions, have their cylinders placed radially, or fanwise, in one or more banks.

The modern aero engine is a masterpiece of design and precision engineering, having a weight of less than 1 lb. per h.p., capable of developing more than 100 h.p. per cylinder, and giving long periods of trouble-free service without overhaul.

**Aero Structure.** The supporting and controlling surfaces of a flying boat, consisting of the main planes, tail unit, and engines. The aero structure and the hull are the two main components of a flying boat.

**Aerobatics.** This refers to evolutions other than those used in normal flight, for example, spinning, inverted flight, rolling, etc.

Originally the slang term "Stunts" was used for these manoeuvres.

**Aerodrome.** See AIRFIELD.

**Aerodrome Beacon.** See AIRFIELD BEACON.

**Aerodrome Lighting.** See AIRFIELD LIGHTING.

**Aerodynamic Balance.** An instrument designed for the purpose of measuring the air forces on aerofoils or other objects being tested in a wind tunnel. The balance is located outside the tunnel and the model under test is connected to it by a

system of fine wires or metal links which transmit the forces to a beam fulcrumed on knife-edges or hardened steel points. The beam is kept in equilibrium by weights from which the magnitude of the aerodynamic forces can be determined.

**Aerodynamic Symbols.** The employment of standard symbols in aeronautical technology has not yet become international. The British Standards Institution has published a list which is used in British practice.

(See also APPENDIX A).

**Aerodynamics.** A term given to the science of air in motion and the forces produced on solid bodies in motion relative to it.

**Aerodyne.** The academic name for any heavier-than-air aircraft or any type of aircraft which obtains its lift in whole or in part from aerodynamic forces.

**Aerofoil.** A surface designed to produce an aerodynamic reaction to the air through which it moves.

**Aerofoil Section.** The cross-section of an aerofoil relative to a given reference plane. In the case of wings, tail planes, etc., the section is generally taken in a plane parallel to the plane of symmetry of the aircraft.

**Aerofoil, Slotted.** See SLOTTED AEROFOIL.

**Aerology.** A branch of meteorology which deals with that part of the atmosphere which is removed from the effects of the earth's surface, i.e. a study of the upper air.

**Aeronaut.** An individual who is in control of an aircraft. He may or may not be the navigator.

**Aeronautical Inspection Directorate.** Generally known as the A.I.D., this was formed by the War Office in 1913, and later became the sole authority for inspecting all British aircraft.

The inspectors of the A.I.D. must be satisfied that all material used

in any part of an aircraft complies with the prescribed specifications, that it is within the appropriate dimensional limits, and that during manufacture the material has not been subjected to any treatment that will destroy its properties.

They are responsible for the soundness and reliability of the complete aircraft, which entails the correctness of the assembly of all detail parts.

**Aeronautics.** A general term which covers all activities in connexion with air locomotion.

**Aeroplane.** A fixed-wing, mechanically driven heavier-than-air aircraft which obtains its lift from aerodynamic forces.

See also AERODYNE.

**Aeroplane and Armament Experimental Establishment.** The Royal Air Force establishment where full-scale experimental research and testing of aeroplanes and their armament are carried out.

**Aeroplane Fabric.** See FABRIC.

**Aeroplane, Pusher.** See PUSHER AEROPLANE.

**Aeroplane, Tractor.** See TRACTOR AEROPLANE.

**Aerostat.** The academic name for any lighter-than-air aircraft, i.e. airship or balloon.

**Aerostatics.** An aeronautical term which refers to the study of the properties of aerostats and their buoyancy in the air.

This term is also used in mechanics and deals with the study of solid bodies and their equilibrium in gaseous fluids.

**Aerostation.** A term which was used to denote the operation or flying of aerostats.

**A.F.C.** See AIR FORCE CROSS.

**A.F.M.** See AIR FORCE MEDAL.

**Aft.** In hull and float construction any position on hull or float usually behind the main step.

**Age-hardening.** If certain aluminium alloys, notably duralumin, are

normalized it is found that under workshop temperature conditions they will commence to harden after about an hour, and that the process continues until the metal has reached its maximum condition of hardness in three or four days. This phenomenon is termed age-hardening.

Age-hardening can be delayed by maintaining the metal, after heat-treatment, at 12° F., and, conversely, it can be accelerated by raising the temperature.

**Agonic Line.** A line on a map or chart joining points on the earth's surface where the magnetic variation is zero.

**A.G.S.** See AIRCRAFT GENERAL STANDARDS.

**A.I.D.** See AERONAUTICAL INSPECTION DIRECTORATE.

**Aileron.** Movable part of the wing, to enable an aerodyne to roll about its longitudinal axis. Ailerons are connected to the control column in such a manner that when the column is moved to the right it raises the aileron on the right wing and lowers the one on the left wing. They are mounted on the trailing edges of the main planes.

**Aileron Actuating Gear.** A mechanism provided for adjusting the trim of an aircraft during flight which operates by altering the setting of the control surfaces.

**Aileron Angle.** The angle between the chord of the movable portion of an aerofoil and the chord of the fixed surface to which it is hinged.

**Aileron Drag.** Drag is the resolved portion of the total air force on a body in a direction parallel to the undisturbed airstream, and it, of course, opposes the motion of the body. When, therefore, the ailerons are moved away from the neutral position increased drag is produced. With the simplest form of ailerons, the down-going one produces greater drag than the up-going one, consequently there is a tendency to

cause the aircraft to yaw. This effect is countered by using differential, frise or other special types of aileron.

**Aileron Lever.** The lever arm by which the aileron is connected to the actuating mechanism.

**Ailerons, Differential.** See DIFFERENTIAL AILERONS.

**Ailerons, Floating.** See FLOATING AILERONS.

**Ailerons, "Frise."** See FRISE AILERONS.

**Aimer, Bomb.** See BOMB AIMER.

**Air.** Air is the name given to the mixture of gases which comprise the gaseous envelope surrounding the earth. Its average composition by volume is: nitrogen 77.94 per cent, oxygen 20.95 per cent, argon 0.94 per cent, carbon dioxide 0.03 per cent, other gases, including helium and neon, 0.14 per cent.

**Air Aide-de-Camp.** Air aides-de-camp attend on duty at courts, levees, investitures and other ceremonies if and when required. They are selected by His Majesty the King on the recommendation of the Secretary of State for Air from officers of the rank of Air Marshal or above and of the rank of Group Captain. There are one principal and two other air aides-de-camp.

**Air Base.** A local base where a maintenance organization is situated for air force units and from which the aircraft operate.

**Air Brake.** A device which increases the resistance of an aeroplane during a glide or when landing. It usually projects out of the wings. Air brakes are an important feature in the design of a dive bomber in order to control the speed of the dive.

**Air Chief Marshal.** Royal Air Force rank corresponding to an Admiral in the Royal Navy and a General in the Army. The distinctive arm badge is one thick ring of braid surmounted by three thinner ones.

**Air Combat.** This term covers fighting between aeroplanes and between aeroplanes and airships. No instances have been recorded of an air combat between airship and airship.

**Air Commandant.** W.A.A.F. rank corresponding to Air Commodore in the Royal Air Force.

**Air Commandant-in-Chief.** W.A.A.F. rank corresponding to Air Vice-Marshal in the Royal Air Force.

**Air Commodore.** Royal Air Force rank corresponding to a Commodore in the Royal Navy and a Brigadier in the Army. The distinctive arm badge is one thick ring of braid.

**Air Compressibility.** From an aerodynamic aspect the compressibility of the air due to the high speeds of aerofoils and propellers plays an important part in design.

When bodies move at slow speeds the air flows round the contours with relatively small changes in pressure and density. But when the velocity approaches the speed of sound, i.e. 1120 ft. per sec. at sea level, sudden changes of density and pressure occur causing considerable increase in drag and, in the case of aerofoils, decrease in lift. This is brought about by the formation at the front of the aerofoil of a stationary compression or shock wave, whilst towards the rear the airflow becomes turbulent.

When a body speeds up, the point at which the type of airflow changes is known as the "critical" velocity. The critical speed in actual fact is lower than the velocity of sound because, even when the aerofoil itself is travelling below sound velocity, the relative air speed at certain points may have reached this value.

The tip-speed of modern propellers approaches that of sound, consequently in the interests of efficiency methods of minimizing

the effects of air compressibility must be investigated.

**Air Control.** A term used to indicate the use of aircraft as the primary arm in support of the political administration for the purpose of creating or restoring order within or without the borders of an undeveloped country. The air arm usually acts in co-operation with land forces.

**Air Convention.** This convention, dated 13th October, 1919, deals with the regulations for air navigation. It also deals with sovereignty of air space; prohibited areas; nationality and registration of aircraft; certificates of airworthiness and competency; air navigation above foreign territory; airfield tariffs; photographic apparatus, etc.

**Air Cooling.** A method used to keep an internal combustion engine at operating temperatures. Fins are fitted to the cylinder in order to increase the heat dissipating area, particularly at the cylinder head, where the greatest amount of heat is generated by the combustion of the fuel.

**Air Council.** The Air Council is the governing body of the Royal Air Force, and orders from the Air Ministry to R.A.F. formations are issued "by command of the Air Council." The Secretary of State for Air presides over the Council. The Parliamentary Under-secretary of State (Commons) is its Vice-President. The Parliamentary Under-secretary of State (Lords) is one of its members.

**Air Defences.** A general term used to denote the various methods of defence against air attack. The methods include attack by fighter aeroplanes, use of anti-aircraft guns, balloon barrage, and camouflage.

**Air Density.** The weight of air per unit volume. As air is a gas, the density will depend upon its tem-

perature and pressure, hence any statement of density should always be made in relation to these variables. At sea level the standard conditions are taken to be a barometric pressure of 760 mm. (29.92 in.) of mercury and a temperature of 15° C. (59° F.). Under these conditions the density of dry air is 0.0765 lb. per cub. ft. or, in mass units, 0.002378 slug per cub. ft.

See also SLUG.

**Air Efficiency Medal.** A medal issued in recognition of long and meritorious service in the Auxiliary or Volunteer Air Force of the Empire. The award may be conferred on officers and airmen of the Auxiliary Air Force or the R.A.F. Volunteer Reserve. The conditions of issue are—

(a) Their service commenced before the 4th September, 1939.

(b) They completed the required period of training and are certified by the responsible authority as efficient and deserving of the award.

(c) They have completed the requisite service of ten years.

The ribbon is green with two central stripes of pale blue  $\frac{1}{2}$  in. in width.

**Air Force.** A term used to denote the resultant force obtained by the reaction of the air on a body moving through it.

**Air Force Cross (A.F.C.).** Instituted by Royal Warrant dated 3rd June, 1918, and granted to officers for exceptional valour, courage or devotion to duty whilst flying, not in active operations against an enemy.

The ribbon is diagonal stripes  $\frac{1}{2}$  in. in width in alternate colours of red and white.

**Air Force Medal (A.F.M.).** Instituted by Royal Warrant dated 3rd June, 1918, and granted to non-commissioned officers and airmen for exceptional valour, courage or devotion to duty whilst flying, not

in active operations against an enemy.

The ribbon is diagonal stripes  $\frac{1}{8}$  in. in width in alternate colours of red and white.

**Air Gap.** The space between the surface of the magnetic pole and the surface of the armature in (i) electric motor, (ii) dynamo, (iii) alternator or similar electric machines.

**Air Gun.** A mechanism used for riveting. It utilizes compressed air and is operated by hand.

**Air Gunnery.** The study of gunnery in the air. With the high speed of aeroplanes, deflection and bullet drop are serious considerations.

**Air Injection Starter.** This is a method of starting an internal combustion engine by means of compressed air. A supply of compressed air contained in a metal bottle is led through a manually-operated valve to a distributor which, being geared to the crankshaft, delivers a charge of compressed air to certain cylinders in correct sequence. When the air blast is turned on, the engine will commence to rotate and the cylinders which are not connected to the compressed air supply begin to fire, thus maintaining rotation. When the air is finally shut off, the remainder of the cylinders pick up and the engine continues to run normally.

**Air Intake Cooler.** A cooler which is fitted to a carburettor air intake, used in hot climates to prevent detonation when the engine is being run at low altitudes.

**Air Intake Heater.** A heater is sometimes fitted to the air intake pipe of an internal combustion engine in order to raise the temperature of the incoming air.

**Air Intake (Neutral Angle).** The speed of an aeroplane affects the amount of air delivered to the carburettor. This excess can be adjusted by altering the shape of

the air intake pipe: If considerably in excess of that required the entry is shaped to combat this effect and is known as neutral angle air intake.

**Air Intake Pipe.** A pipe connected to the carburettor through which all the incoming air enters the induction system of an engine. The air is required to supply the oxygen necessary for the combustion of the fuel.

**Air Intake (Scoop Type).** If the amount of air delivered to the carburettor is less than that required to obtain complete combustion of the fuel, an air intake of scoop shape is directed forward to increase the quantity of air taken into the carburettor manifold.

**Air Intake (Seaplane or Desert Type).** Aeroplanes for use on the sea or in the desert must be protected from the ingress of spray or sand to the engine. The air intakes are therefore raised to minimize the quantity of foreign matter which can enter with the air.

**Air Intakes.** See AIR INTAKE (NEUTRAL ANGLE); AIR INTAKE (SCOOP TYPE); AIR INTAKE (SEAPLANE OR DESERT TYPE).

**Air Lag.** A term used to define the horizontal distance at any height between the flight path of a real and an ideal bomb if they are both released from an aircraft at the same instant.

**Air Law.** By various Acts of Parliament, several of which were placed on the Statute Book between the years 1911 and 1919, control of civil aviation in Great Britain and Northern Ireland has been effected. A further Act was passed known as the Air Navigation Act, 1920, which included all the previous provisions. Under this Act rules and orders are issued from time to time; the first order, the Air Navigation Order, 1922, was cancelled by the Air Navigation (Consolidation) Order, 1923. The Act is administered by

means of the Air Navigation Directions which are issued by the Secretary of State for Air. These Acts were further amended by the Air Navigation Act (1936).

**Air League of the British Empire.**

This league was founded in 1909 as "The Aerial League," and was reorganized in 1926. It is a non-political, independent organization of private citizens, who are solely concerned to see that aviation is properly directed for the security, consolidation and prosperity of the British Empire. It is in three sections: (a) Intelligence, (b) Editorial and Publicity, and (c) Subscriptions and Finance.

**Air Licences—Personnel.** See "A" LICENCE (PILOT); "B" LICENCE (PILOT); INSTRUCTORS' CERTIFICATES; NAVIGATORS' LICENCES; GROUND ENGINEERS' LICENCES; BALLOON PILOTS' LICENCES; AIRSHIP PILOTS' LICENCES; WIRELESS OPERATORS' LICENCES; EXHIBITION PARACHUTISTS' LICENCES; GLIDING CERTIFICATES.

**Air Lock.** Obstruction of the flow of a fluid due to a bubble of air in the pipe. This bubble usually occurs in the top of a bend in a pipe.

**Air Log.** An instrument which records the air mileage flown by an aircraft. It is of particular use to the navigator when flying over unfamiliar territory or when stars and other landmarks are not visible, enabling him to plot his course by dead reckoning. It is constructed on the principle of the anemometer with an appropriate recording mechanism.

**Air Mail.** See AIR POST.

**Air Marshal.** Royal Air Force rank corresponding to a Vice-Admiral in the Royal Navy and a Lieutenant-General in the Army. The distinctive arm badge is one thick ring of braid surmounted by two thinner rings.

**Air Mass.** An extensive mass of

air in which the conditions of temperature and moisture content are uniform in a horizontal plane.

**Air Member for Personnel.** A member of the Air Council who is responsible for the management, welfare, and health of the Royal Air Force personnel and the Women's Auxiliary Air Force personnel at home and abroad.

**Air Member for Supply and Organization.** A member of the Air Council who is responsible for the supply and servicing of equipment, transportation, and civil engineering works.

**Air Member for Training.** A member of the Air Council who is responsible for combat and flight training of aircrews and technical training of ground personnel.

**Air Meter.** A portable instrument for determining the velocity of the wind.

See also ANEMOMETER.

**Air Ministry.** A department of State which controls and administers the Royal Air Force and civil aviation.

**Air Ministry Orders.** Orders issued periodically to members of the Royal Air Force.

**Air Navigation.** The science of guiding an aircraft from its point of departure to its destination. The pilot or navigator should know the aircraft's position at any moment.

**Air Navigation Act, 1920.** This Act is the basis of British air law. The details are set out in the Air Navigation (Consolidation) Order (1923) as amended by subsequent orders. The Air Navigation Act (1936) is an Act to amend the law with respect to aviation.

**Air Navigation (Consolidation) Order, 1923.** This order lays down the general conditions of flying in Great Britain and Northern Ireland.

**Air Navigation Directions.** The detailed administration of the Air Navigation Act, 1920, is effected by

these directions, which are issued by the Air Ministry. They deal with the technical requirements of aircraft and personnel.

**Air Officer Commanding.** A title used to indicate that a R.A.F. unit is commanded by an officer of air rank, i.e. Air Commodore, Air Vice-Marshall, etc.

**Air Officer Commanding-in-Chief.** The senior R.A.F. officer in a command, when such a command has other officers of air rank, in command of sub-units, such as Groups or Stations.

**Air Photography.** The science of photography in its special application to air work.

See also AIR SURVEY.

**"Air Pilot for Great Britain and Ireland."** An official publication which assists pilots to keep in touch with the ever-increasing number of regulations which should be known by all aviators. It is a loose-leaf book bound in stiff blue covers, and supplements are issued from time to time.

The *Air Pilot* has published a complete list of the Acts, Orders, Amendments, Regulations, and Directions which are applicable to pilots.

**Air Pilotage.** The art of taking an aircraft from one point to another by using visible ground landmarks to ascertain the position at any particular time. This entails identifying objects on the ground after reading the map. Air pilotage does not necessarily mean going from one prominent landmark to another, but steering a straight course and identifying the landmarks as the aircraft passes over them.

**"Air Pocket."** Colloquial term for down-draught.

**Air Post.** The carrying of postal matter by aircraft originated on a commercial basis during the war 1914-18. In November, 1919, the

Postmaster-General established an air post to France, Italy, Spain, and Switzerland. In addition to the ordinary postal charge, 2s. 6d. per ounce was added.

**Air Publications.** Publications issued by the Air Ministry for the guidance of R.A.F. personnel. A number are on sale to the public.

**Air Raid.** A raid over enemy territory or enemy-occupied territory for the purpose of dropping bombs, and/or using cannons or machine guns, with the object of reducing the enemy's war potential.

**Air Raid Wardens.** Personnel drawn from the civilian population who volunteer to act as wardens in the event of air raids. Some are paid full-time wardens, and it is incumbent on them to be available at all times during their period of duty. Part-time wardens are available when not at their normal place of duty. They are detailed for definite sectors or areas.

**Air Rank.** All ranks of the Royal Air Force above and including Air Commodore.

**Air Reconnaissance.** Flights made by aircraft to discover the disposition of the enemy or to ascertain damage done by air raids, gunfire, etc.

**Air Records.** World records are divided into four main phases—

(a) Greatest speed for a straight line course.

(b) Distance records.

(c) Height records.

(d) Duration records.

All records, if they are to secure official international recognition, must be certified by the Fédération Aéronautique Internationale. This Federation controls air sport as recognized by the principal countries of the world.

**Air Resistance.** See DRAG.

**Air Route.** The course flown over between two airfields. An air route organization usually consists of—

(a) Terminal airfields or airports.  
(b) Intermediate forced landing grounds.

(c) Lighting beacons, wireless and meteorological services.

**Air Scoop.** An extension of the air intake to the carburettor designed to ensure an adequate supply of air to the engine.

It may also refer to a scoop, attached to the ballonet of an aerostat, to intake air, depending upon the speed of the aerostat.

**Air/Sea Rescue.** A section of the Royal Air Force consisting of aircraft and marine craft for rescuing airmen forced to land in the sea.

See also A.S.R.

**Air Sickness.** Due to ear, eye, and general bodily sensitivity.

See also ANOXAEMIA.

**Air Speed.** The speed of an aircraft relative to the air through which it is passing as distinct from the speed relative to the ground.

**Air Speed Computer.** A mechanical device for converting indicated air speed to true air speed.

See also AIR SPEED INDICATOR.

**Air Speed, Indicated.** See INDICATED AIR SPEED.

**Air Speed Indicator.** An instrument which indicates, subject to certain corrections, the speed of the aircraft relative to the air. The most common type is the Pitot-static indicator, which in principle consists of two parallel tubes placed parallel to the axis of the aircraft. One tube has an open end which points in the direction of flight, and the other has its end closed, but round its circumference are drilled a number of small holes. The opposite ends of the tubes are connected to the inside of a hermetically sealed aneroid capsule and the airtight interior of the recording instrument case, respectively. The open-ended tube will measure the kinetic head plus the static pressure head of the

air, whilst the other will only record the static pressure head. Thus, if one is led to the inside of the capsule and the other to the outside, the capsule will react to the pressure differential between the two, and a pointer connected to the capsule by a suitable mechanism will indicate the dynamic pressure only. Hence as the dynamic pressure is proportional to the velocity it is a simple matter to calibrate a scale in miles per hour, knots, etc.

This type of instrument is subject to an inherent error in that the dynamic or kinetic head depends upon the density of the air and thus will read low at altitude. This may be corrected by use of the air speed computer.

**Air Speed Indicator Calibrator.** The purpose of this calibrator is to provide a portable standard against which the accuracy of air speed indicators may be checked.

**Air Speed Recorder.** The air speed recorder is an autographic device used on aeroplanes to record air speed on a time base. It secures a record in graphical form of the speeds attained over a period.

**Air Staff.** A Royal Air Force designation for the personnel which deals with operations, intelligence, organization, and training.

**Air Station.** A place from which all types of aircraft are operated. This includes both land and sea stations.

**Air Survey.** This is a specialized branch of aviation and deals with the survey of tracts of country from the air. The procedure is, for an aeroplane fitted with special cameras to be flown at a predetermined height over the area concerned and a series of photographs to be taken. The photographs are pieced together somewhat in the manner of a mosaic and from this a map is prepared. The value of this method



of survey is that country which is difficult to traverse on the ground can be readily covered, and also the work can be completed very quickly.

**Air Temperature.** The variation of temperature over the earth's surface is of considerable importance in meteorology as it is the key to many of the processes which form part of the atmospheric conditions. Temperature is the condition which determines the flow of heat from one substance to another. The average fall in temperature in relation to height is 3° F. per 1000 ft., although this may vary from day to day.

**Air Tube Cooler.** An oil cooler so designed that the air passes through the tubes which are surrounded by the oil.

**Air Vice-Marshal.** Royal Air Force rank corresponding to a Rear-Admiral in the Royal Navy and a Major-General in the Army. The distinctive arm badge is one thick ring of braid surmounted by one thinner one.

**Air Volume.** The volume (in the case of an aerostat) of air displaced by a solid body of the size and shape of the envelope.

**Aircraft.** A general term which includes aerodynes and aerostats, i.e. any structure which has been designed for support by aerodynamic force or buoyancy.

**Aircraft Apprentice.** Boys are entered into the Royal Air Force between the ages of 15 and 17 for training in one of the five following trades—

- (a) Fitter (for engines or airframes).
- (b) Fitter Armourer.
- (c) Radio Mechanic.
- (d) Instrument Maker.
- (e) Electrician.

The period of training is normally of three years' duration.

They are enlisted for twelve years' service which commences

after reaching the age of 18. On reaching the age of 27 an aircraft apprentice may be selected for further service to complete twenty-four years, on completion of which he is entitled to a pension.

The badge worn by an aircraft apprentice consists of a four-bladed propeller surrounded by a ring. The same badge is worn by apprentice clerks.

**Aircraft Carrier.** Units specially designed to accommodate and operate aircraft with the fleet. This type of ship has a large hangar with a clear flush deck free from obstructions for taking off and alighting. The first British aircraft carrier was a converted tramp steamer which was renamed the "Ark Royal."

**Aircraft Engine Starters.** See AIR INJECTION STARTER; CARTRIDGE STARTER; HAND INERTIA STARTER; HAND STARTER; INERTIA STARTER.

**Aircraft Establishment.** The number of aeroplanes which are authorized to be issued to a unit. The establishment allows a number for immediate use and a number to be held in reserve.

**Aircraft Fabric.** See FABRIC.

**Aircraft General Standards.** This is a system for the standardization of small parts common to many types of aircraft—bolts, nuts, rivets, fork ends, etc.—made in a range of suitable sizes. The same parts may be made of different materials, and a distinguishing system of identification markings is in use.

**Aircraft Landing Flare.** A pyrotechnic flare which a pilot uses to illuminate the earth's surface before alighting. It is normally attached to the underside of an aircraft.

**Aircraft Lighting.** The lighting system in an aircraft.

**Aircraft Markings.** See REGISTRATION MARKS.

**Aircraft Tender.** A land vehicle or ship specially constructed for attending to aircraft.

**Aircraftman.** Classification in the Royal Air Force corresponding to the Able Seaman and Ordinary Seaman in the Royal Navy and the Private, Trooper, Gunner, Sapper, etc., in the Army. The classification is divided into Aircraftman 2nd class, Aircraftman 1st class, and Leading Aircraftman, and applies to all trades. The grading is dependent on the results of a technical examination, 40 per cent for A.C. 2, 60 per cent for A.C. 1, and 80 per cent for L.A.C.

**Aircraftwoman.** A classification in the W.A.A.F. similar to that for Aircraftman.

**Airfield.** A specially defined area from which aircraft operate. The term includes any building or installation intended for use either wholly or in part for the operation of the aircraft and the comfort of the personnel.

**Airfield Beacon.** Lights located at or near an airfield with the object of indicating its position.

**Airfield Lighting.** The general system of lighting on an airfield at night to facilitate landing or recognition.

**Airflow.** The term used to define the movement of the air in relation to a body moving through it or the air flowing over a stationary body.

**Airframe.** An aeroplane with its engine or engines removed, i.e. the structure.

**Airline.** A civil organization which operates aircraft regularly over an air route.

**Airman.** Official designation of non-commissioned officers and men of the Royal Air Force. It is not applied to commissioned officers.

Colloquially it is used to refer to any person who pilots an aircraft.

**Airmanship.** This term refers to the handling and operating of aerodynes and aerostats on the ground and in the air.

**Airport.** An airfield used by

commercial aircraft as a point of arrival and departure. It is provided with all the necessary facilities for repair of aircraft, accommodation of passengers, and customs' requirements.

**Aircrew.** See PROPELLER.

**Airship.** A lighter-than-air aircraft which is propelled by mechanical means. The types are rigid, semi-rigid, and non-rigid.

The rigid airship is so named because it is built to shape by a system of metal girders and wire bracing, the gas being contained in ballonets secured within the structure.

The envelope of the non-rigid type is constructed of fabric and acquires its shape when inflated, as does the semi-rigid type, but in the latter case the envelope is stiffened by a keel which also takes the load carried by the airship. Nose stiffeners are sometimes built up from the keel.

**Airship, Non-rigid.** See AIRSHIP; NON-RIGID AIRSHIP.

**Airship Pilots' Licences.** These licences are in three grades: 1st, 2nd, and 3rd class. Holders of them may pilot any airship registered in Great Britain for either private or commercial purposes.

The 1st Class licence entitles the holder to take charge of an airship of any size. The holders must have a Balloon Pilot's Licence and a Navigator's Certificate. Their experience must cover a period of at least four months and include five flights totalling fifteen hours as the 2nd Class Pilot of an airship of greater capacity than 700,000 cub. ft.

The 2nd Class licence entitles the holder to command any airship of less than 700,000 cub. ft. capacity. Applicants for this licence must hold a Balloon Pilot's Licence and a Navigator's Certificate. Their flying experience must cover a period of

four months and include ten flights as the pilot of an airship of greater capacity than 200,000 cub. ft.

The 3rd Class licence entitles the holder to command any airship of a capacity of less than 200,000 cub. ft. Candidates must hold a Balloon Pilot's Licence and a Navigator's Certificate. They must have made at least twenty airship flights, three of which should have been by night, and made a 70-mile cross-country flight with a night landing. Candidates must be between the ages of 19 and 45 for all three certificates. Licences are valid for twelve months.

**Airship, Rigid.** See AIRSHIP; RIGID AIRSHIP.

**Airship, Semi-rigid.** See AIRSHIP; SEMI-RIGID AIRSHIP.

**Airship Shed.** A building erected for the sole purpose of housing aerostats.

**Airship Station.** An area provided with the necessary facilities for mooring, housing, and maintaining airships.

**Airway.** An air route with the necessary ground organization for the efficient maintenance of aeroplanes or airships.

**Airway Beacon.** A beacon so located that it indicates an air route. Such beacons may show a light or they may emit radio signals.

**Airway Lighting.** The system of lighting along an airway route, similar to lightships for marine navigation.

**Airworthiness.** A term applied to component parts of an aircraft or a complete aircraft. It denotes that the regulations for the safety of the aircraft and its occupants have been complied with.

**Airworthiness Certificate.** See CERTIFICATE OF AIRWORTHINESS.

**Alclad.** The name given to sheets of duralumin which have been coated on each side with pure aluminium. The aluminium covering is approximately 11 per cent

(half on each side) of the total thickness of the sheet. The advantages are—

(a) The pure aluminium coating is more resistant to corrosion than duralumin.

(b) The aluminium covering is electropositive, thus protecting the duralumin from electrical corrosion.

(c) High strength with lightness.

**Alcohol.** A spirit obtained, by distillation from vegetable matter, e.g. wood, grain, potatoes, etc., having the chemical formula  $C_2H_5OH$ . It is frequently used as a fuel for internal combustion engines, particularly of the high-compression-ratio, racing type, because of its good anti-detonation qualities. It is not so volatile as petrol, hence it does not give easy starting, but when mixed with petrol makes an ideal fuel. Another point in its favour is its lower freezing point, thus resisting the formation of ice in carburettors. It is also used in thermometers designed for measuring temperatures below that at which mercury freezes.

**"A" Licence (Ground Engineers).** A certificate issued to persons over the age of 21, who may be of either sex, and who have had satisfactory practical experience and have passed an examination on the inspection of aircraft before flight.

Licences are valid for one year at a fee of 21s., and may be renewed at a fee of 5s. on evidence of recent practical experience in the duties covered by the licence.

**"A" Licence (Pilot).** This licence is for the private individual who wishes to fly for pleasure or for his own business purposes. It may entitle the holder to fly any type of aeroplane almost anywhere. If he makes no charge for his services, the certificate allows him to carry passengers and goods.

Candidates for this licence may be of either sex, and must be of

average health and ability. The medical examination may be carried out by the candidate's own doctor in accordance with certain standards laid down by the Air Ministry.

The following conditions must be fulfilled before a licence is granted—

(a) Be at least 17 years of age. There is no upper age limit.

(b) Pass the medical examination.

(c) Demonstrate their flying ability by passing two practical flying tests.

(d) Produce evidence of having flown for a total of at least three hours as the sole occupant of an aeroplane.

(e) Pass an oral examination in the rules governing air navigation and international air legislation.

The tests under (c) consist of—

(1) A test for altitude and gliding flight of not less than 2000 ft. At this height the pilot must switch off the engine or throttle down to the minimum and land within 150 yds. of a previously specified point.

(2) A flight round two posts or marks 500 yds. apart in figure-of-eight turns. Five series are made at not higher than 600 ft. and the landing must be within 50 yds. of a specified point.

The oral test (e) is of an elementary nature, and is designed to ensure that the holder of the licence is well acquainted with the rules of the air and the international laws governing aviation. The candidate may be examined on any or all of the following—

(1) General conditions governing flying in countries which are parties to the International Air Convention.

(2) General conditions governing flying in countries which are *not* parties to the International Air Convention.

(3) United Kingdom Regulations.

The Royal Aero Club will issue to the candidate on passing the test an Aviator's Certificate of the

Fédération Aéronautique Internationale. This certificate does not require renewal; it is insufficient to comply with the British regulations governing pilots, who must obtain the "A" licence, but entitles the pilot to fly in most foreign countries.

The "A" licence is valid for one year.

**Alighting.** The manoeuvre of an aircraft as it approaches and makes contact with the land or water.

See also **LANDING**.

**Alighting Gear.** This gear includes, in addition to the undercarriage, the tail skid and, where fitted, the floats, but not the hull of a flying boat. It supports an aircraft on land or water.

**Alkali.** A chemical substance often used as a grease, paint, or dirt remover from metallic surfaces, and sometimes as an electrolyte.

**Alloys.** In its broadest sense an alloy is any metallic substance which is not a chemical element. In practice it is a substance consisting of two or more metallic elements or of metal and non-metal elements which are mixed when molten and have not separated into distinct layers when solid.

**Alpax.** An aluminium alloy containing approximately 13 per cent of silicon. This alloy is suitable for castings, the silicon facilitating the flow of the metal.

**Alpha Ray.** One of the types of radiation that is emitted by radioactive substances.

**Alternating Current.** An electric current varying in magnitude and direction periodically. Starting from zero it smoothly but quickly increases to a given maximum and then diminishes to zero. After completion, it grows to a maximum in reverse and again drops to zero. An alternating current may reverse its direction up to forty to fifty times per second in the case of

normal industrial supply, and in the case of radio circuits this figure may be even a million times per second. From these possibilities emanates the term "high frequency current."

**Altimeter.** An instrument which is virtually an aneroid barometer, and is calibrated to indicate the height of an aircraft above a specified datum, generally sea level. As the instrument is affected by variation of barometric pressure, provision is made for adjustment.

**Altimeter Calibrator.** This device consists of a small airtight chamber having a plate-glass window and which is capable of being exhausted of air by means of a small vacuum pump. Connected with the interior is either a standard altimeter or a mercury manometer. The altimeter to be calibrated is placed within the chamber, which is then sealed and the air pressure progressively reduced, when the reading of the instrument being tested may be compared with that of the standard one. Alternatively, the height of the mercury column can be noted and, by reference to tables, the corresponding altitude determined.

**Altimeter, Recording.** See RECORDING ALTIMETER.

**Altitude.** The vertical height above a given or known datum, the datum generally being sea level. Altitude is usually expressed in feet or metres.

**"Altitude Control."** See MIXTURE CONTROL.

**Altitude, Maximum Power.** See MAXIMUM POWER ALTITUDE.

**Altitude, Rated.** See RATED ALTITUDE.

**Alto-cumulus** (Ac. or A.Cu). A form of cloud built up of a layer or patches of cloud composed of laminae or rather flattened globular masses, the smallest elements of the regularly arranged layer being fairly small and thin, with or without

shading. The thin and transparent edges often show rainbow colours which are rather characteristic of this type of cloud. At high levels this cloud resembles cirro-cumulus.

**Alto-stratus** (As. or A.St.). A cloud formation shaped like a channelled or fibrous veil, more or less grey or bluish in colour. This type of cloud is similar to the cirro-stratus type, but without halo phenomena.

**Alumina.** The only known oxide of aluminium ( $\text{Al}_2\text{O}_3$ ). It is of a white crystalline nature, and is used as an abrasive.

**Aluminium.** A chemical element whose symbol is Al. Aluminium is one of the lightest metals known, having a density of 0.0943 lb. per cub in.; it is silver-white in colour, soft and ductile and, in the pure state, resistant to corrosion. It is mined in the form of an ore called bauxite, and is readily refined by a combined chemical and electrical process. Unfortunately, it is not very strong, having a tensile strength of about 7 tons per sq. in., but on the other hand it alloys readily with nickel, copper, magnesium, silicon, iron, etc., and in this form plays an important part in the aircraft industry.

**Aluminium Alloys.** Alloys formed by combining pure aluminium with other metals, such as chromium, copper, magnesium, manganese, nickel, silicon, and zinc. These elements may be added singly, or in combination to produce the characteristics which are required. Aluminium alloys can be used for castings.

**Aluminium Brass.** An aluminium alloy which is used for making intricate castings. It can also be forged. Aluminium brass has a high resistance to corrosion, but is less ductile than aluminium.

**Aluminium Rectifier.** An electrolytic rectifier. It is a device used for

converting an alternating current into a direct current. The negative side (cathode) is of aluminium.

**Aluminium-beryllium Alloys.**

Aluminium alloys which contain small percentages of beryllium, approximately  $\frac{1}{4}$  to 2 per cent. Beryllium has the effect of hardening the alloy. The wrought alloys have high tensile strength and good machining properties.

**Aluminium-magnesium Alloys.**

The most generally used aluminium-magnesium alloy contains approximately 10 per cent magnesium. Aluminium alloys with approximately 1 per cent of magnesium are capable of being heat-treated. The addition of magnesium improves the corrosive resistance of aluminium.

**Aluminium-manganese Alloys.**

If manganese is added to aluminium alloys in very small quantities the physical properties of these alloys are improved. Approximately  $\frac{1}{4}$  per cent is normal.

**Aluminium-silicon Alloys.** These are light alloys which contain about 12 per cent of silicon and the remainder aluminium. Occasionally copper and other elements may be added. These alloys are very suitable for castings as they do not suffer from shrinkage cracks.

**A.M.O.** See AIR MINISTRY ORDERS.

**Ammeter.** A measuring instrument employed for indicating the rate of flow of electrical currents in amperes.

**Ampere.** This is the name given to the unit by which the rate of flow of an electric current is measured. The international definition of the ampere may be expressed as follows: When a steady current passes through a solution of nitrate of silver under specified conditions and deposits metallic silver at the rate of 0.00118 gram per sec., the rate of flow is one ampere. Another

way of defining it is: When a potential difference of one volt is applied to the ends of a conductor whose resistance is one ohm, then the current which will flow is one ampere.

**Amphibian.** An aeroplane provided with the necessary fittings for rising from or alighting on either land or water.

**Amplidyne.** This is similar to the ordinary D.C. generator. It is a machine which converts mechanical energy into electrical energy. Its principal feature is its high ratio of amplification which requires considerably less power to excite its control field for a definite armature output. The comparatively weak output of the servo-amplifier excites the control field sufficiently to operate the drive motor.

**Amplidyne Motor Generator.** This is a two-bearing rotating machine in a single housing. It consists of a 24-volt D.C. motor driving an amplidyne generator, which is a sensitive generator requiring very low field current to produce sufficient power to drive the motor. A most important characteristic of this machine is that it has a very fast rate of response to any change in the field current, thus making the control of the drive motor extremely sensitive to a selsyn output.

**Amyl Acetate.** A colourless liquid of the chemical composition  $\text{CH}_3\text{-COOC}_5\text{H}_{11}$ . It is insoluble in water but will dissolve in alcohol and ether. It is used as a solvent for some paints and varnishes, and is a common ingredient of many aeroplane dopes. It also dissolves celluloid, and is therefore used in repairing certain types of celluloid accumulator containers.

**A.N.A.** See AIR NAVIGATION ACT.

**Anabatic Wind.** A localized wind caused by convection currents set up in the air due to local temperature variation.

**Anchor.** A hook-like device made of forged steel which is attached to one end of a cable and cast overboard for the purpose of holding a flying-boat, seaplane, or ship stationary.

See also DROGUE.

**Anchorage.** A position where seaplanes or other surface craft can lie at anchor.

In engineering, the word is sometimes used to denote a lug or bracket to which some member of a structure may be attached.

**A.N.D.** See AIR NAVIGATION DIRECTIONS.

**Anemograph.** A self-recording anemometer. The instrument may record the direction of the wind in addition to its velocity.

**Anemometer.** An instrument for measuring the velocity of the wind or of an airstream.

**Anemoscope.** An instrument which indicates the existence of a wind and its direction.

**Aneroid Barometer.** An instrument for determining atmospheric pressure. It consists of one or more flat, circular, hermetically-sealed, metallic boxes which have been partially exhausted of air and whose sides are corrugated in circles to make them springy and sensitive to variations of barometric pressure on the outside. As the atmospheric pressure increases the boxes tend to collapse inwards; the greater the pressure the greater the inward movement of the corrugated surfaces. With reduction of external air pressure the surfaces spring outwards like diaphragms. This movement is communicated against a large flat spring through suitable linkage to a pointer which moves over a scale calibrated in inches of mercury. The standard barometric pressure at sea level is 14.7 lb. per sq. in., which is the equivalent of 29.92 in. or 760 mm. of mercury.

**Angle of Attack.** A colloquial

term for "Angle of Incidence." It is the angle between the datum line in an aerofoil and the line of relative wind direction, or the angle between the chord of an aerofoil and its direction of motion relative to the air.

**Angle of Downwash.** When the airstream passes over and under the wings of an aeroplane it is deflected downwards. Relative to the direction of the undisturbed airflow, the angle through which the air is deflected downwards is called the angle of downwash. This angle is not constant but depends upon the angle of attack of the main planes and the distance behind the wings at which it is measured. The angle of downwash affects the positioning and setting of the tail plane.

**Angle of Glide.** In normal flight there are four forces, neglecting a small force on the tail, which act on an aeroplane, viz. lift, weight, thrust, and drag. When the engine is cut-out or throttled right back, the forces acting on the machine will maintain equilibrium if the resolved component of the weight parallel to the flight path takes the place of the propeller thrust and is the force which drives the aeroplane. To obtain this condition the longitudinal axis of the machine must be tilted, and it will be approaching the ground. When the value of the resolved component of the weight is just equal in magnitude to the total drag, the aeroplane will attain a steady speed, and the angle is referred to as the angle of glide. For any given aeroplane there will be an angle of glide associated with each angle of attack.

**Angle of Incidence.** See ANGLE OF ATTACK; ANGLE OF INCIDENCE (RIGGERS).

**Angle of Incidence (Riggers).** The angle between the chord line of the main supporting surfaces and the horizontal datum when an aerodyne is in an arbitrary rigging

position on the ground. This position is laid down by the manufacturers.

**Angle of Pitch.** The angle between the longitudinal axis and the direction of motion of the aircraft when in horizontal flight.

**Angle of Roll.** The angle through which an aeroplane must be turned about its longitudinal axis in order to bring its lateral axis into the horizontal position. The angle is positive when the left or port side is higher than the right or starboard side.

**Angle of Stall.** If an aerofoil is placed in an airstream and its angle of attack progressively increased, its lift coefficient will increase also until an angle of some 15 to 18 degrees is reached, depending upon the shape of the aerofoil section. Beyond this point the lift rapidly decreases and the aerofoil is said to stall. The angle of maximum lift is called the critical or stalling angle.

**Angle of Sweep-back.** The angle at which the main planes are set back in relation to the fuselage or hull.

**Angle of Yaw.** The angle between the direction of the relative wind and the longitudinal axis of an aeroplane. The angle is positive when the aeroplane turns to the right or starboard.

**Ångström Unit.** A unit of length normally used in expressing the wave-length of light. It is equal to 0.00000001 or  $10^{-8}$  centimetres. The micron is equal to 10,000 ångströms.

**Angular Velocity.** Angular velocity is the angle through which any radius of a rotating body turns in a unit of time. It is generally expressed in radians per second.

**Animal Lubricants.** Lubricants made from animal tissue. Lard oil, neatsfoot oil, sperm oil, tallow are types of animal lubricants. They are good lubricants at normal temperatures but under certain condi-

tions fatty acids are thrown off and tend to dry up, therefore they are not used as internal combustion engine lubricants. They are used for oiling clocks, sewing machines, and instruments which operate at normal temperatures.

**Annealing.** A method of relieving internal stresses in or altering the properties of a metal by heating and cooling. Generally the effect is to soften the metal to allow it to be "worked" or machined.

**A.N.O.** See AIR NAVIGATION (CONSOLIDATION) ORDER.

**Anode.** The conductor through which an electric current enters an electrolyte when the principle of electrolysis is being applied.

**Anodize.** An anti-corrosive treatment in which a metal article is given a protective layer of oxide. It is made the anode of an electrolytic action, with a carbon cathode. The length of treatment depends upon the material.

**Anoxaemia.** Sickness which is frequently met with at high altitudes owing to lack of oxygen. It may extend to complete loss of consciousness or merely lack of judgment. Aviators are advised if attempting to reach high altitudes to commence using the oxygen apparatus from the start.

**Antennae.** See AERIAL.

**Anti-aircraft.** Term applied to the various methods of action against aircraft in war, usually abbreviated A.A.

**Anticyclone.** A region of high barometric pressure. In this type of atmospheric distribution the winds in the southern hemisphere are anti-clockwise and in the northern hemisphere they are clockwise.

**Anti-drag Wires.** Wires that take the forces which are in the opposite direction to the drag on an aerofoil.

**Anti-flutter Wire (Airship).** A wire for reinforcing locally the outer cover of an airship and for reducing



flutter due to air pressure or propeller slipstream. Sometimes known as the "outer cover support wire."

**Anti-freeze.** A substance added to the liquid in the cooling system of an internal combustion engine to lower its freezing point. It should not boil away at operating pressures and temperatures. Ethylene glycol is in general use for aeroplane engines.

**Anti-friction Metals.** Used in aero engines as bearing metals. The properties of anti-friction metals are: (a) a low coefficient of friction; (b) sufficient plasticity to allow the crankshaft to bed down; and (c) sufficient compressive strength to carry the load. Examples are white-metal, lead-bronze, etc.

**Anti-knock Fuel.** A fuel in which certain chemicals, such as tetra-ethyl-lead, have been added in order to decrease the possibility of detonation which might occur if standard fuel were used in high compression internal combustion engines.

Certain hydrocarbon fuels such as iso-octane and benzol are inherently good from the anti-detonation point of view, as also is alcohol. These substances mixed with ordinary petrol reduce the tendency to detonate.

**Anti-lift Wires.** Those wires which carry the weight of the wings or any other down load between the wing and the fuselage of an aeroplane when it is standing on the ground. Sometimes called landing wires.

**Antilogarithm.** See LOGARITHM.

**Anti-rolling Wires.** The wires fitted to an aerostat to prevent the rolling of any component relative to the hull or envelope.

**Anti-trade Winds.** Reverse winds occurring sometimes at 3000 ft. or more above the trade wind.

**A.O.C.** See AIR OFFICER COMMANDING.

**A.O.C. in C.** See AIR OFFICER COMMANDING-IN-CHIEF.

**A.P.** See AIR PUBLICATIONS.

**Aperiodic.** An instrument needle which does not oscillate, but indicates the reading after a slight lag.

**Aperiodic Type Compass.** A type of dead beat stability incorporated in many compasses. The magnet assembly is balanced against a damping force. No overswing of the needle takes place, and it swings to its position slowly and without oscillation.

**Apprentice Clerk.** Boys are entered into the Royal Air Force between the ages of 15½ and 17 years for training in clerical work. The period of training is approximately eighteen months, during which period they are taught practical office work, shorthand, typewriting, précis writing, indexing, etc. They are enlisted for twelve years' service, which commences after reaching the age of 18. On reaching the age of 27 an apprentice clerk may be selected for further service to complete twenty-four years, on completion of which he is entitled to a pension. The badge worn by an apprentice clerk consists of a four-bladed propeller surrounded by a ring. The same badge is worn by aircraft apprentices.

**Approach Light.** A special distinctive light for indicating a favourable line of approach to an airfield.

**Apron.** A hard surface area of considerable extent laid down immediately in front of a hangar on which aircraft can be readily manoeuvred. Sometimes called the tarmac.

**Arbor.** An accurately ground shaft, for supporting and keeping in exact alignment machine parts or cutting tools during machining operations.

**Archaeology.** Aeroplanes have been and are being used to discover

prehistoric sites. Photographs from the air indicate if the earth had been dug. This is shown by the formation of the soil and its effect on growing crops or grass.

**Archimedes' Principle.** When a solid body is immersed in a fluid, a force equal to the weight of the fluid displaced acts upward and opposes the action of gravity. Thus, for floating bodies, the weight of fluid displaced is equal to the total weight of the body.

**Arcing.** The formation of an electric arc. Jumping of an air gap by electric current.

**Arctic Air.** Air masses which originate over the ice and snow of the Arctic or Antarctic regions.

**Ardur.** The trade name given to a liquid which welds together fully cured bakelite materials and urea-formaldehyde resins.

**Aries.** A constellation. The first sign of the zodiac, and designated by the sign of the ram's horn,  $\varphi$ .

**Arming Vane Stop.** A stop which prevents the arming vanes of a bomb rotating whilst in position on an aircraft.

**Arming Vanes.** Blades fitted to a bomb which rotate during its fall and render it "live."

**Aromatics.** These are natural anti-knock constituents of a fuel. Aromatics usually found are benzene, toluene, and xylene.

**Arresting Gear.** The equipment incorporated in aircraft and on certain landing areas to facilitate landing in a confined space, for example, on the deck of an aircraft carrier.

**Arrow Engine.** An engine with three rows of cylinders, the centre being vertical and the other two rows inclined, forming the shape of a broad arrow in end view.

**Articulated Connecting-rod.** An articulated rod which joins the master connecting-rod by means of a pin. It is used in "V" and radial type engines.

**Artificial Ageing.** Certain metals, notably aluminium alloys, undergo structural changes if left standing at normal atmospheric temperature for a length of time. This process can be accelerated by appropriate heat-treatment, and this is sometimes referred to as artificial ageing. The effect of this treatment may be to remove internal stresses, produce hardness, or allow the metal to develop its maximum strength.

**Artificial Horizon.** An instrument which simulates the natural horizon, giving an indication of both the fore-and-aft and the lateral trim of an aircraft. This information is most desirable when flying entirely by instruments through fog, clouds or rain. It is operated by a gyro, which usually takes its power from a venturi fitted outside in the airstream, or the gyro may be driven by an engine-operated vacuum pump.

**Asbestos.** A non-combustible material, possessing a crystalline fibrous structure, which can be spun into sheets and which is used for heat insulation. It is employed in the manufacture of fire-proof bulkheads in aeroplanes.

**Aspect Ratio.** The ratio of the span to mean chord of an aerofoil,

i.e.  $\frac{\text{Span}}{\text{Chord}}$ . In the case of an aerofoil

having a chord of varying lengths it is usual to express the aspect ratio in terms of the area of the aerofoil and the square of the span, thus—

$$A = \frac{\text{Span}^2}{\text{Area}}.$$

**Aspirated Engine (Normal).** See NORMALLY ASPIRATED ENGINE.

**A.S.R.** Letters used to denote air/sea rescue. The letters are used as a prefix to the mark number of the aeroplane and denote its duty. For example, Walrus A.S.R. II.

**Assembly Drawing.** A drawing which shows a number of parts erected to form a unit which is to

be installed in another assembly or in the aeroplane, e.g. a connecting-rod assembly of a radial engine consisting of the master connecting-rod to which are fastened the articulated rods.

**Assistant Section Officer.** Rank in the W.A.A.F. equal to that of Pilot Officer, R.A.F.

**Astrodome.** A look-out on the top surface of the fuselage of an aeroplane from which celestial bodies can be observed. It is also used for general observation purposes.

**Astronautics.** The science of flight in and above the upper regions of the atmosphere of the earth. Sometimes called "space" flight in order to avoid confusion with flight where there is sufficient air to obtain lift from the aerofoils. The prime mover visualized under such conditions is some form of rocket apparatus.

**Astronomical Navigation.** A science by which a navigator is able accurately to fix his geographical position by making observations of heavenly bodies, such as the sun, moon, planets, and stars.

**Athodyd.** This is a thermodynamic duct, and is used as a propulsion unit in certain types of aircraft. It has been in little use except for the flying bomb.

**Atmosphere.** The atmosphere is the mechanical mixture of gases surrounding the earth. The four major constituents are nitrogen, oxygen, argon, and carbon dioxide. The atmosphere is approximately 200 miles thick.

See also AIR.

**Atmosphere, International Standard.** See INTERNATIONAL STANDARD ATMOSPHERE.

**Atmospheric Motion.** Movement of the air caused by its being heated unequally by the sun. The hotter portions rise and vertical air currents are created, and as a result

wind or horizontal air currents are set up.

See also CONVECTION.

**Atmospheric Pressure.** Atmospheric pressure equals 29.92 in. of mercury. A barometric pressure of 29.92 in. of mercury accompanied by a temperature of 59° F. is known as "standard air." The atmosphere rises to some 200 miles above the earth's surface and consequently exerts a pressure which is a maximum on the earth's surface at sea level and decreases with altitude. The standard barometric pressure at sea level is 14.715 lb. per sq. in., 29.92 in. of mercury or 760 mm. of mercury when the temperature is 59° F. Atmospheric pressure is measured by a barometer.

**Attitude.** This term refers to the angle of an aircraft's three principal axes in relation to (a) the airstream, and (b) the ground.

**Attitude of Flight.** The position of the three principal axes of an aircraft in flight relative to the undisturbed air.

**Aurora.** A luminous phenomenon considered to be due to electrical discharges in the atmosphere. It is confined to the air at high altitudes, and is most generally seen in sub-arctic and sub-antarctic latitudes. When it occurs in the northern hemisphere it is known as aurora borealis, and when in the southern hemisphere as aurora australis.

**Austenite.** A solid solution of carbon or iron carbide ( $\text{Fe}_3\text{C}$ ) which occurs in iron. It changes into cementite (iron carbide,  $\text{Fe}_3\text{C}$ ) and ferrite (pure iron) when the steel is cooled slowly below a temperature not less than 690° C. Austenite is non-magnetic.

**Autogiro.** The trade name referring to a type of gyroplane manufactured by—

Cierva Autogiro Co., Ltd., Feltham, Middlesex.

Lift is obtained from three

rotating aerofoils whose axis of rotation is approximately normal to the longitudinal axis of the machine.

**Automatic Boost Control.** A device, generally incorporated in an aero-engine carburettor, which automatically regulates the boost pressure to some predetermined value. Essentially it consists of a stack of hermetically-sealed capsules acted upon by the boost pressure, one end of which is fixed, the other carrying a piston valve which covers and uncovers parts communicating with the high pressure engine-oil supply, or alternatively with the delivery side of the supercharger. Variation of the boost pressure causes the capsules to expand or contract, effecting movement of the piston valve which then causes oil (or air) to be delivered to a servo-piston which accordingly opens or closes the throttle a sufficient amount to maintain a constant boost pressure.

See also MANIFOLD PRESSURE GAUGE.

**Automatic Control.** An instrument which controls an aeroplane in flight about one or all three of its principal axes automatically by a gyro. Its general principle of construction depends upon the fact that the axis of a spinning gyroscope tends to remain fixed in space. If this axis is set parallel to the axis of the aircraft, then any movement of the latter will be relative to the gyro. This movement of the aircraft away from its zero position uncovers valves which bring into action a servo-piston which by suitable linkage operates the flying controls until the machine returns to its original attitude.

**Automatic Mixture Control.** A carburettor unit which regulates the amount of fuel entering the induction manifold so that the fuel/air mixture ratio is kept con-

stant, regardless of the altitude or air density. The necessity for its incorporation in an aero-engine carburettor is due to the fact that as the distance above the earth's surface increases so the air density decreases, thus tending to produce an over-rich air/fuel mixture. The automatic mixture control cuts down the fuel supply from the main jets as the aircraft ascends, and vice versa, thus maintaining the mixture strength.

**Automatic Parachute.** A parachute which is attached to the load and opens automatically during its fall.

**Automatic Propeller.** A propeller whose blades are automatically set by mechanical means at their optimum pitch for various flight conditions.

See also CONSTANT SPEED PROPELLER.

**Automatic Stability.** Stability which is dependent upon automatically-operated control surfaces.

**Automatic Valve (Aerostat).** A valve fitted to aerostats and arranged to open and close automatically at a predetermined pressure in the envelope.

**Auto-rotation.** A characteristic of all aerofoils. When an aerofoil is mounted symmetrically in an airstream at its maximum angle of attack, on an axis at right angles to the wind direction, it will, once rotation has started, accelerate to a constant rate of revolution and continue to do so as long as the same conditions prevail.

**Auxiliary Air Force.** The Auxiliary Air Force is a voluntary organization, composed of auxiliary air force squadrons, in which members render part-time service while continuing to follow their civil occupations. Balloon squadrons also form part of the Auxiliary Air Force.

The squadrons are raised and

maintained by Territorial Army and Air Force Associations. Personnel are enlisted for a County or other area for which a County Association has been formed, and are posted to a squadron within that area. Applicants for appointment to commissions or for enlistment in the ranks should apply to the Commanding Officer of the unit they wish to join. During war the Auxiliary Air Force is part of the Royal Air Force.

**Auxiliary Parachute.** A small parachute attached above the main parachute which assists in withdrawing the main parachute from its pack.

**Auxiliary Tank.** A tank which is fitted to carry a reserve supply of fuel.

**Aviation.** Term embracing all forms of flying.

**Aviator.** The pilot of an aircraft.

**Aviator's Certificate.** A certificate issued by the Royal Aero Club to personnel who pass certain defined tests.

**Avigation.** A term which is sometimes used when referring to air navigation.

See also AIR NAVIGATION.

**Avogadro's Law.** Under equal pressures and temperatures, equal volumes of all gases contain equal numbers of molecules.

**Axes.** An axis of a solid body is an imaginary straight line passing through the centre of gravity; similarly, for an area the axis passes through the centroid.

An aeroplane has three principal axes—

(a) Lateral axis (q.v.).

(b) Longitudinal axis (q.v.).

(c) Normal axis (q.v.).

These three axes are mutually at right angles.

**Axial Engine.** An engine whose cylinders are arranged parallel to the crankshaft, colloquially called a swash-plate engine.

**Axial Girder.** A girder along the axis of a rigid airship which connects the centres of each braced transverse frame. It is secured to the hull structure fore and aft.

**Axial Wire.** A wire which is substituted for the girder structure.

See also AXIAL GIRDER.

**Axle Booms.** Transverse horizontal members, forming part of the undercarriage of a seaplane.

**Axle Troughs.** Troughs built in the top or crown of a float, being integral with the main structure at that point, and designed to receive the axle booms.

**Azimuth.** When used in connexion with aeronautical instruments this means the angular displacement in a horizontal plane.

## B

**B.** Letter used to denote bomber aircraft. The letter is used as a prefix to the mark number of the aeroplane and denotes its duty; for example, Mosquito B V.

**Babbitt Metal.** An alloy used for lining bearings. Babbitt metal belongs to the "tin base alloys." In addition to tin, it usually contains one or more of the following: copper, antimony, lead, and arsenic. Often termed "anti-friction metal" because it has a low coefficient of friction.

**Back.** A term used in connexion with the direction of the wind meaning to change direction counter-clockwise, i.e. N., W., S., E.; opposite to veer. In scientific practice this definition now applies to both hemispheres.

**Back E.M.F.** When a coil is part of a closed circuit and an alternating electromotive force is flowing in the circuit a magnetic field is produced which will alternate in space. The lines of force will cut the coil and induce in them an e.m.f. This e.m.f. is in the opposite direction to the applied e.m.f. and is called the back e.m.f.

**Backing.** A term used to denote a counter-clockwise change in the direction of the wind. The opposite to veering. Thus, if the direction of the wind changed from, say, north to north-west, it would be said to be backing.

**Backwash.** The air which flows backwards as a result of the action of a propeller.

**Baffle Plate.** Any plate used to deflect or obstruct the flow of fluids, e.g. perforated metal plates running from one side to the other inside a fuel tank. The purpose of this type of baffle is to prevent surging of the fuel. Baffles are sometimes placed

between the cylinders of air-cooled engines or in specified positions to deflect the cool air on to the cylinders.

**Bakelite.** The trade name of the Bakelite Corporation for a synthetic plastic derived from the phenol-resins. Used as an insulator and for certain moulded parts in electrical systems, instruments, panels, etc. Articles made of this material are generally formed in dies under high pressure, and may be produced in almost any colour. They have a tendency to brittleness.

**Balance.** A condition of steady flight in which the system of forces acting upon the aeroplane are in equilibrium.

**Balanced Controls.** A control surface which has extensions on both sides of the axis of the hinge so as to reduce the moment of the air forces about the hinge. The portion in front of the hinge meets the airstream in such a direction that the resultant force will assist the pilot to move the control into the desired position. Another method of assisting the pilot to operate his control surfaces is the fitting of "balance tabs." These are small movable surfaces hinged to the trailing edges of rudders, elevators, etc., which by suitable linkage are moved in the opposite direction to that which it is desired to move the main surface, thus exerting a turning effect which reduces the effort required by the operator.

**Balancing.** The act or operation of locating the centre of gravity of an aircraft. This term is also used in connexion with rotating bodies such as propellers, crankshafts, etc. When a body is rotating at high speed it is essential that the centrifugal force on each part

cancels the force on other parts. If this is not done vibration will occur, and additional loading will be placed on the bearings. A state of balance can be obtained either by material being removed or additional weights added at the appropriate points of the propeller. It is often sufficient in the case of a propeller to ensure that it is in "static" balance. This means that if the shaft is placed on knife edges the propeller or similar rotating part will remain at rest in any rotational position. The problem is more complex in the case of crankshafts where there are rotating masses in several planes. In addition to "static" balance there must also be a state of "dynamic" balance. In cases of this kind the sum of the moments of the centrifugal force set up about any reference plane must be zero.

**Bale-out.** A colloquial term meaning to leave an aircraft and descend by means of a parachute.

**Ball Bearing.** A bearing employing hardened steel balls which run between outer and inner races. Ball bearings are designed to support radial loads or thrust loads, and their value lies in the lower frictional resistance they offer to relative movement between two surfaces, by substituting rolling friction for sliding friction.

**Ballast.** Usually sand or water which is carried in a balloon or airship and thrown out for the purpose of reducing the load carried in order to alter its buoyancy or trim. Aeroplanes sometimes carry ballast in lieu of passengers, etc.

**Ballasting Up.** The act of releasing ballast or gas with the object of adjusting the buoyancy or trim of an aerostat.

**Ballistics.** A term used in connection with armament and applying to the calculations dealing with the line of flight of bullets, bombs, etc.

**Ballonet.** A gas-tight container constructed of fabric and placed within a balloon or an airship. It is normally inflated with hydrogen or helium to provide the lift.

**Balloon.** An aerostat without a power plant.

**Balloon Flying Cable.** The cable which connects a captive balloon to the winch.

**Balloon Pilots' Licences.** There are two grades, one for the pilotage of balloons used for private purposes and known as the "balloon pilot's licence for private balloons," and the other for pilotage of balloons used for public transport and known as the "balloon pilot's licence for commercial balloons."

Pilots' licences for private balloons are valid for twelve months, those for commercial balloons for two years.

**Balsa Wood.** The wood of a tree which is common in the West Indies and Central America. Its extreme lightness makes it a useful wood for use in the construction of aeroplane models. It is of value for fairings on external struts or surfaces of aeroplanes. It weighs approximately 8 lb. per cub. ft.

**Bank.** To incline an aeroplane for the purpose of turning so that there is an angle between the lateral axis and the horizontal plane.

**Bank Indicator.** A flight instrument which indicates rotation of the aeroplane about the longitudinal axis. It may be a simple instrument consisting of a small weighted pendulum or a ball acting in a short curved horizontal glass tube, and suitably dampened by a fluid against oscillatory motion. The more scientific "bank indicators" have a gyroscope to maintain a reference level.

**Banked Turn.** A normal turn by an aircraft. The lateral axis of the aeroplane is inclined to the horizontal, the wing-tip on the inside

of the turn being depressed whilst the other is raised. This is done to resist the centrifugal effects, just as a motor speed-track is banked-up at bends. If a flat unbanked turn is made the aeroplane will skid outwards.

**Bar.** In meteorology this is a unit of pressure equal to 1,000,000 dynes per cubic centimetre. A bar equals 100 centibars and 1000 millibars. One millibar equals 0.75 millimetre of mercury. Thus the unit used in meteorology is a barometric pressure of 75.008 centimetres of mercury at 0° C., which is 29.53 in. of mercury at 32° F.

**Barograph.** A barometer which is self-registering. It records the static pressure of the atmosphere. It consists essentially of a stack of aneroid capsules connected to a pointer which carries a pen-like device at its end. The pen is pressed up against a roll of specially scaled paper which is mounted vertically and rotated once every twenty-four hours. By the combined movements of the pointer and the paper a graph is drawn showing the barometric pressure for the past day.

**Barogram.** The record made by a self-registering barometer.

**Barometer.** An instrument which measures the pressure of the atmosphere. There are two principal types, the mercurial and the aneroid. A micro-barometer is used when very small changes of pressure are required to be recorded.

**Barometric Pressure.** The pressure exerted by the atmosphere as registered by a barometer.

At sea level the pressure is approximately 14.7 lb. per sq. in., but is subject to slight variation which depends on local conditions (such as temperature, humidity, wind speed). At a height of 18,000 ft., barometric pressure is approximately 50 per cent of that at sea level.

**Barometric Tendency.** The alteration in the barometric pressure during the three-hour period before an observation.

**Barothermograph.** An instrument which records simultaneously the pressures and temperatures of the atmosphere.

**Barrage Balloon.** A captive balloon, used to support wires which are intended as a protection against attacks from the air.

**Base Line.** A technical term which is used in hull and float construction. It denotes the datum line from which all vertical dimensions are taken.

**Base Metal.** The metal which is the main constituent of any combination of metals or of an alloy. In welding technique it is the metal which is to be welded. After welding, the metal in the weld usually has a composition different from that of the base metal.

**Basket.** The structure for carrying the crew and ballast which is suspended from the envelope of a balloon.

**Battery.** When a number of primary or secondary cells are connected together the name battery is applied.

**Battery, Dry.** This varies from the ordinary cell type inasmuch as the small primary cells have moist instead of liquid chemicals. Apart from a small vent hole the cells are hermetically sealed to prevent leakage, hence the name dry.

**Battery, Inert.** A battery, similar to the dry type, specially designed for service in hot climates.

Until water is added this type of battery will remain inactive for long periods and does not deteriorate in transit or storage.

**Bay.** The portion of a fuselage between adjacent bulkheads or frame positions. In a wing it is the structure included between two points of attachment of interplane



bracing members of a biplane or a triplane. It may be a single-bay or a two-bay, etc., depending on the number of bays on each side of the longitudinal axis.

**Bay Longitudinal.** That section of a longitudinal member between adjacent transverse frames of an aerostat.

**"B" Battery.** American terminology for a high-tension battery.

**"B" Certificate (Glider).** A certificate issued for competency in the flying of gliders. It is issued by the Royal Aero Club of the United Kingdom under conditions laid down by the International Aeronautical Federation. There are three grades of certificates, Classes A, B, and C, C being the highest category.

For Certificate B the test consists of a flight of at least one minute's duration with two turns in the form of an S. A normal landing must be made.

The candidate must previously have made two separate gliding flights, each of not less than 45 sec. duration.

**B.E.** See **BRITISH EXPERIMENTAL**; **BLÉRIOT EXPERIMENTAL**.

**Beaching Trolley.** An arrangement of wheels which are attached to the floats of a seaplane or the hull of a flying boat to permit handling ashore.

**Beacon.** A luminous device which sends out signals indicating position on the earth's surface.

**Beading.** Forming a small groove or corrugation in metal in order to stiffen a sheet or part.

**Beading Machine.** A machine consisting of two rollers of various sizes and shapes whose peripheries meet in such a manner as to form the required shape in the metal. Sometimes called a jenny.

**Beam.** A region at the centre of two overlapping signals from two directional radio aerials which are

of equal strength. The beam is a narrow strip (having an approximate total width of 3°) within which neither of the two different signals can be distinguished. The only sound heard is a steady monotone.

The term is also applied to the major lateral horizontal axis at any point on a hull or float, usually taken from chine to chine at individual frames. In engineering it is any member which carries lateral loads.

**Bearing.** In mechanical engineering, a bearing is a component designed to carry a moving part, e.g. crankshaft main bearing, camshaft bearing, connecting-rod big end bearing. In order to reduce friction to a minimum between the moving surfaces these must be smooth and well lubricated, also anti-friction metals, e.g. white-metal, lead-bronze, etc., are used to line the bearing. Ball bearings and roller bearings are extensively used because of their low frictional resistance.

In navigation, a bearing is the angle between any fixed line or datum (generally the earth's magnetic meridian) and a straight line from the observer to any given point. It is expressed in degrees measured in a clockwise direction from the datum. A bearing may be "true" or "magnetic," depending upon the meridian from which it is measured.

**Bearing Plate.** A navigational device used for determining the bearing of an object in relation to the longitudinal axis of an aircraft.

**Bearing Projector.** A projector used with a landmark beacon for indicating a specific direction by using the beam from the beacon.

**Beaufort Notation.** A system, originated by Admiral Sir Francis Beaufort, for recording weather conditions by means of numbers.

**Beaufort Scale of Wind Velocity.**

A scale devised by Admiral Sir Francis Beaufort in 1806. It contains thirteen divisions of force, ranging from 0 (calm) to 12 (hurricane), each representing an approximate velocity as indicated by the effect wind has on trees, smoke, flags, open bodies of water, and many other objects.

See also *APPENDIX C*.

**Bell Crank.** A lever having two arms which are usually set at right angles to each other. Its chief purpose is to afford a means of changing the direction of a transmitted force.

**Bend Allowance.** The estimated amount of sheet metal required to make a bend over a known radius, from the start of the bend to the finish of the bend. The amount of the allowance depends on the thickness of the metal, the type of metal used, the radius of bend, and the degree of bend. In calculating the dimensions of the development of a fitting it is general practice to work to the centre line of the thickness of the plate.

**Benzol.** A volatile hydrocarbon spirit obtained by distillation from coal-tar, consisting essentially of benzene ( $C_6H_6$ ) and smaller percentages of toluene ( $C_7H_8$ ) and xylene ( $C_8H_{10}$ ). It is "water-white" in colour like petrol and has a distinctive aromatic odour. Benzol is an excellent fuel for internal combustion engines, having a calorific value only slightly lower than petrol, a specific gravity of 0.82, and good anti-detonation qualities. It is frequently mixed with petrol to improve the anti-knock, or octane number, of fuel for use in engines having a relatively high compression ratio.

**Bernoulli's Theorem.** This relates to the flow of liquid in tubes, etc., and broadly states that, neglecting friction and losses due to other causes, the energy possessed by a

fluid when it passes one point is equal to its energy when it passes a second point.

**Beryllium.** A metal, chemical symbol Be. It is very strong and light, with a specific gravity of 1.84. Its weight is about 68 per cent of that of aluminium. The ore is plentiful, but it is very expensive to produce beryllium on a commercial basis.

**Bessemer Steel.** This is the name given to steel made by the Bessemer process.

Bessemer furnaces are large steel containers, mounted on trunnions, which can be tipped over for the purposes of filling and emptying and which are lined with dolomite. The great advantage of this process is that it enables practically all the carbon—apart from other impurities—to be removed from the "melt." This is accomplished by blowing a hot-air blast from the bottom up through the molten metal, thus oxidizing the carbon, manganese, phosphorus, and silicon. When all the carbon has been removed the correct amount of carbon is then added, in this way producing a homogeneous steel possessing the required amount of carbon within close limits.

**B.H.P.** See BRAKE HORSE-POWER.

**Bias.** This denotes that fabric has been cut diagonally across the warp and weft.

**Biased Fabric.** A multi-ply fabric cut so that the warp threads in one or more of its plies lie at an angle to the length.

**Big End.** The crank pin end of an engine connecting-rod.

**Bi-monoplane.** This is a type of aeroplane in which after take-off the upper plane is detached and the aeroplane continues on its flight as a monoplane. The idea is to lower the wing loading at take-off by use of the added wing. The added wing is discarded when the aeroplane has

reached its economical cruising height.

**Biplane.** An aeroplane which has two main supporting surfaces one assembled above the other.

**Bise.** A cold, dry, wintry wind which blows from the north-west, north, or north-east in the mountainous regions of Southern France.

**Bi-signal Zone.** See TWILIGHT ZONE.

**Bituminous Paint.** A paint with a heavy black tar base. It is used for waterproofing the internal portions of seaplane floats and the hulls of flying boats, etc. Synthetic lacquers which have superior properties are being used instead of bituminous paint.

**Black Heart.** This is the term used to indicate an internal rotting of wood.

**Blackout.** This is a momentary failure of the eyesight which is experienced by pilots during high-speed turns or other rapid manoeuvres. It is caused by blood being drawn away from behind the eyes by centrifugal force. The period of blackout can be lessened by having the feet higher and the head bent down towards the knees.

**Blade Angle.** The angle between the chord of a section of a propeller and a plane perpendicular to the axis of rotation of the propeller.

**Blank.** A sheet metal part after it has been cut out of the flat sheet. It is a blank until a forming operation has been carried out either in a press or by hand.

**Blast Furnace.** A furnace which uses an air blast to assist in the smelting of iron from its ores.

**Blangas.** A gas fuel which was used in airships by the Germans. It was composed of a mixture of ethylene, butylene, methane, propylene, ethane, and hydrogen.

**Bleeding.** This refers to the expulsion of air from hydraulic systems. All hydraulic systems

have special arrangements for bleeding purposes.

**Blériot Experimental.** An experimental type of aircraft built by Blériot in France in 1909.

**"B" Licence (Ground Engineer).** The requirements for the award of the ground engineer's "B" licence are laid down in the Air Navigation (Consolidation) Order of 1923. Briefly, this licence is issued to competent persons of either sex who are capable of the inspection of aircraft after overhaul. They are endorsed for approved types only.

Licences are valid for one year at a fee of 21s., and may be renewed at a fee of 5s. on evidence of recent practical experience in the duties covered by the licence.

**"B" Licence (Pilot).** This is a commercial licence and must be held by all persons who fly passenger or mail aircraft, or aircraft which can be used for other industrial purposes.

Applicants may be of either sex and any nationality, and must be between the ages of 19 and 45. They must have had at least 100 hours' solo flying experience.

**Blimp.** A colloquial term which refers to a small, non-rigid airship.

**Blind Flying.** See INSTRUMENT FLYING.

**Blind Landing.** More correctly termed beam or instrument landing, this is of particular value at night or under conditions of bad visibility. The fundamental principle of beam landing is as follows. A radio short-wave beam is sent out from the landing ground in the direction in which it is desired that the machine shall land. A receiving apparatus in the aircraft emits different sound signals when the aeroplane is on one side or the other of the beam, so that by balancing them it is quite easy for the pilot to fly directly down the beam. Proceeding in the correct direction,

the pilot is told his height above the ground at given instants, and in this way is guided safely down.

**Blizzard.** A violent, intensely cold wind, which is laden with snow.

**Blood-albumen Glue.** A glue which is made from the dry blood albumen of cattle. As compared with ordinary animal glue it has a high degree of water-resistance. Its greatest use is in the manufacture of plywood, when it gives a joint strength of approximately 250 lb. per sq. in. when dry tested, and approximately 130 lb. per sq. in. when wet tested.

**Blower.** A mechanism used with an internal combustion engine and which is similar to a centrifugal type supercharger. It is used principally on non-supercharged radial-type engines in order to overcome the difficulty of charge distribution to the cylinders rather than to increase the amount of air or the density of the charge. Supercharging has as its principal function the increase of the density of the charge to the cylinders.

**Blueprint.** A drawing which has been printed on a chemically-treated paper by exposure to an intense electric light. The result is a blue colour background, and where the chemical has not been affected because of the black lines of the tracing, the white colour of the paper remains.

**Blushing.** Milky-looking spots which sometimes appear on the doped surfaces of fabric parts of aircraft. Blushing is caused by the precipitation of cellulose nitrate or cellulose acetate and is due to too much moisture and cold air being present in the doping shop. It is an undesirable feature and must be avoided by carrying out the doping under the correct temperature and humidity conditions.

**B.M.E.P.** See BRAKE MEAN EFFECTIVE PRESSURE.

**Boat Seaplane (Flying Boat).** A seaplane in which the buoyancy when on water is obtained by means of a hull.

**Body Plan.** A series of vertical half transverse sections of a hull or float, drawn with a common centre line, usually showing fore body on one side and after body on the other.

**Bollard.** Usually an upright post or fitting, external on hull, to which lines, cables, etc., for mooring purposes may be attached.

**Bomb.** A container, together with the devices for detonating, exploding, or igniting the explosive or incendiary contents.

**Bomb Aimer.** The airman who aims and releases the bomb by using the bomb sight and release mechanism.

**Bomb Carrier.** The structure for carrying bombs on an aircraft.

**Bomb Release Control.** A control which operates one or more bomb release mechanisms, normally operated electrically.

**Bomb Sight.** An instrument used by a bomb aimer to estimate that a bomb dropped from an aeroplane in flight will strike its objective.

**Bomber.** An aeroplane designed to carry bombs and drop them on enemy objectives. The name indicates size, weight, power, range, or destructive characteristics.

**Bombing Teacher.** A synthetic device to simulate real conditions and enable bomb-aiming to be taught on the ground.

**Bonding.** A method whereby all metal parts of an aircraft are joined together to avoid different electrical potentials between the components. If this were not done it would be possible for electric sparks to occur, thus increasing the fire risk.

**Boom Well.** A trough-like recess in the deck plating of a float. Such wells take the end fittings of the struts. Sometimes called the boom trough.

**Boost.** The pressure obtained in an induction manifold by the use of a supercharger.

To supply an engine with more air or air/fuel mixture than would normally be induced owing to the displacement of the piston on the downward induction stroke.

**Boost Control.** See AUTOMATIC BOOST CONTROL.

**Boost Gauge.** A type of aneroid which indicates the pressure in the induction pipe. The zero on British boost gauges indicates atmospheric pressure, i.e. 14.7 lb. per sq. in.

See also MANIFOLD PRESSURE GAUGE.

**Boost Pressure.** The pressure in the induction system of supercharged engines at a point specially selected for each type. It is British practice to place the supercharger between the engine and carburettor, and to connect the boost gauge at a point on the delivery side of the supercharger casing. The pressure is normally expressed in pounds per square inch, though American gauges are calibrated in inches of mercury. For practical purposes, 2 in. of mercury correspond to 1 lb. per sq. in. When converting pressures from inches of mercury to pounds per square inch it should be remembered that the former is "absolute" pressure, i.e. measured from zero pressure, and allowance must be made for the atmospheric pressure. A simple example will illustrate this point, viz. boost pressure 50 in. of mercury; standard atmospheric pressure 30 in. of mercury. The reading on a British boost gauge corresponding to 50 in. of mercury on an American one would be  $50 - 30 = 20$ . 20 in. of mercury = 10 lb. per sq. in.

**Bora.** A cold, squally, north-east wind which occurs in the winter on the northern shore of the Aegean and Adriatic Seas.

**Bore.** The inside diameter of a cylinder of an engine.

**Bottom Dead Centre.** The position when the piston of an engine is at the greatest possible distance from the cylinder head, i.e. the piston has travelled its maximum distance toward the bottom or inner end of the cylinder.

**Boundary Layer.** Under even the best conditions of streamline flow the layer of air immediately adjacent to a solid body has its movement retarded by friction with the surfaces of the body. It is clear from this that the successive layers of air near to the body will be moving at different speeds, that adjacent being practically stationary, the next moving a little faster, and so on the farther they are away. This region where the velocities are different from that of the main airstream is only a few thousandths of an inch thick, and is known as the "boundary layer."

Obviously, the rougher the surface and the more viscous the fluid, the thicker will be the boundary layer.

**Boundary Lights.** A group of lights which are placed to indicate the confines of a landing area.

**"Bourdon" Tube.** An element of a pressure-recording instrument which translates the internal pressure into mechanical movement to actuate an indicator needle. Bourdon tubes are usually made of brass, copper, or bronze, and are of a flat, oval shape cross-section having thin walls and are bent into a flat spiral or more generally in the form of a "C."

In a pressure gauge the free end is closed whilst the opposite end is fixed and connected to the pressure to be measured. Internal pressure tends to cause the tube to assume a circular cross-section, which has the effect of causing the free, closed end to uncoil or open outwards.

The greater the pressure, the greater the movement of the end. This movement is transmitted to a pointer by means of a suitable mechanism.

**Bow Cap.** A cap which forms the extreme forward end of the envelope of an airship.

**Bow Stiffeners.** Stiffeners arranged radially round the bow of a kite balloon, non-rigid or semi-rigid airship to stiffen the forward end against air pressure.

**Bow Waves.** The waves which are formed by the bow of a hull or boat moving through water. These waves require energy for their formation, and must therefore be taken into account in water resistance calculations for boats and seaplane hulls.

**Box Girder.** A built-up girder of hollow rectangular section.

**Box Spar.** A spar of rectangular cross-section used in aircraft construction.

**Boxing the Compass.** Naming the compass points in their regular sequence. There are thirty-two points which appear on a compass card and which divide the horizon into thirty-two equal divisions. The compass is boxed in the following sequence: North, north-by-east, north-north-east, north-east-by-north, north-east, north-east-by-east, east-north-east, east-by-north, east, east-by-south, east-south-east, south-east-by-east, south-east, south-east-by-south, south-south-east, south-by-east, south, south-by-west, south-south-west, south-west-by-south, west-south-west, west-by-south, west, west-by-north, west-north-west, north-west-by-west, north-west, north-west-by-north, north-north-west, north-by-west, north.

**Boyle's Law.** A law relating to gases. Provided the temperature remains constant, the volume of a given gas will vary inversely as the

pressure to which it is subjected. Occasionally referred to as "Mariotte's Law." It may be written  $P \times V = \text{constant}$ .

**Brake Horse-power.** The power available from an engine for useful work at the shaft, sometimes called shaft horse-power, and generally measured by means of a dynamometer (or brake). The fundamental formula for the calculation of brake horse-power is—

$$\text{B.H.P.} = \frac{\text{Torque} \times 2\pi N}{33,000}$$

where the torque is measured in pounds-feet and  $N$  in revolutions per minute.

**Brake Mean Effective Pressure.** The average pressure in the combustion chamber of an engine during the power stroke needed to provide the b.h.p.

**Brazing.** A means of joining metals by the use of a mixture of copper, zinc, and tin. It requires a higher temperature than silver soldering and lower than that required for welding. The strength of a brazed joint is greater than that of a silver soldered joint and less than that of a welded joint. The brazing metal enters into solid solution with the parent metal near the joint. The flux used is borax.

**Brazing Spelter.** Usually composed of a mixture of copper and zinc in varying percentages. The strongest spelter is one composed of approximately 55 per cent copper and 45 per cent zinc.

**Breaking Stress.** The stress at which a test specimen of a material breaks.

**Breeze.** A wind of moderate strength.

See also GLACIER BREEZE; LAND BREEZE; MOUNTAIN BREEZE; SEA BREEZE; VALLEY BREEZE.

**Brinell Hardness Test.** A test carried out by using a hardened steel ball which makes contact with

the test specimen under a known load. The diameter of the indentation made by the ball is measured in millimetres, and the hardness number of the metal determined from the formula—

Hardness No. =

Load in kg.

Spherical area of indentation in sq. mm.

The steel ball used for hard metals has a diameter of 10 mm., which penetrates into the material to be tested, under an applied load of 3000 kg. for 30 sec. For soft metals the applied load is 500 kg. for 60 sec.

**British Aircraft Mark.** This mark was introduced by the Air Ministry for the purpose of distinguishing aircraft which are of British construction and are also in possession of a certificate of airworthiness.

The mark consists of a lion rampant in gold within three rings of red, white, and blue. The words "British Certificate of Airworthiness" are inscribed in the white ring.

**British Engineering Standards Association.** See BRITISH STANDARDS INSTITUTION.

**British Experimental.** A type of biplane designed and built by the Royal Aircraft Establishment and produced in 1909. Generally known as the B.E.

**British Standards Institution.** The British Standards Institution was originally founded in 1901 as the Engineering Standards Committee. It was in 1918 incorporated as the British Engineering Standards Association. This institution exists to assist industries by preparing standard specifications as required by the leading engineering institutions in Great Britain.

**British Thermal Unit (B.Th.U.).** This is a unit of heat expressed in pound-degree Fahrenheit units. It may be defined as the quantity

of heat required to raise the temperature of 1 lb. of water 1° F. It is the equivalent of 778 ft.-lb. of energy.

**Brittleness.** The absence of plasticity in a metal or a material, i.e. lack of ductility, malleability, or toughness.

**Broach.** A hardened steel tool with serrated cutting edges, which is pulled or pushed through a hole in materials to form a required size or shape.

**B.S.I.** See BRITISH STANDARDS INSTITUTION.

**B.Th.U.** See BRITISH THERMAL UNIT.

**Bubble Sextant.** A sextant using a spirit-level to provide an artificial horizon. It is generally used for finding the altitude of a celestial body.

**Buffeting.** An irregular oscillation of a part of an airframe produced and maintained by the eddying airflow from some other part of the structure.

**Bulk Modulus.** Bulk modulus, sometimes called volume modulus, is the ratio between the stress and change in initial volume due to forces acting on each face of a cube of the material.

**Bulkhead.** Bulkheads are closed frames used in the construction of a float or hull and may or may not be water-tight. The term is also used to denote the closed fireproof frame between the engine and the remainder of the fuselage in certain aircraft.

**Bulkhead Wiring.** A system of wires arranged radially across the main transverse frames of a rigid airship for separating adjacent gas bags as well as supporting their ends when inflated.

**Bullet.** A projectile propelled by the force generated by an explosive charge. There are a number of types of bullet, viz. explosive, incendiary, and expanding.

**Bump.** A colloquial term used to indicate a sudden movement of the aircraft due to eddy currents in the surrounding air. In meteorology it refers to an unstable atmosphere in which local vertical air currents are formed.

**Bumping Bag.** A fender which is secured to the underside of a car or basket of an aerostat to prevent damage from contact with the ground.

**Bunt.** A manoeuvre in which an aeroplane carries out the first half of an inverted loop, i.e. with the upper surfaces of the aeroplane on the outside of the circle, and then half rolls to regain normal flight.

**Buoyancy.** The condition of floating.

The vertical up-thrust on an aeroplane, resulting in an aerodynamic reaction of the relative wind across its various lifting surfaces, when numerically equal to the weight of the machine, produces a condition of buoyancy.

In the case of an airship or balloon, flotation will occur when the weight of the "lifting" gas plus the weight of the structure, fabric, etc., is equal to the weight of air displaced.

**Buran.** A strong north-east wind (usually in the winter) occurring in Russia and Central Asia.

**Burble Point.** When the flow of air over the wing breaks down, the stream of air, instead of following the surface, forms eddies of disturbed and turbulent movements. This is known as the "burble point," and it is that point at which the wing loses its lift, and stalls.

**Burbling.** A separation and breakdown of the airstream on an aerofoil, which results in a loss of lift and an increase of drag. In other words, when the airflow ceases to be streamlined and eddies are set up, the formation of such eddies

is sometimes referred to as "burbling."

**Burnish.** A term used to denote a method of polishing a metallic surface by the friction of another smooth metallic surface. A lubricant is generally used.

Another method to obtain a high polish on a machined surface is to use a rotating burnisher which consists of a number of robust cloth discs clamped to a shaft. The shaft is run at high speed and centrifugal force keeps the fabric rigid enough for the object being polished to be pressed up against it in the same way as one would use a grindstone.

**Butterfly Valve.** This is an almost circular disc-like valve carried by a shaft passing through its diameter. It is fitted in a cylindrical housing in the carburettor of a petrol engine, or in the main steam pipe of a steam engine. One end of the shaft passes through the pipe and is capable of being rotated through about 90° by a suitable linkage. When opened the disc is end-on to the passage of the fluid, and when closed it completely blocks the passage by seating round its edge on the inside of the housing. When used in a petrol engine as described, it is called the throttle valve.

**Butt Joint.** A joint in which the two edges of the parts to be joined are placed together, i.e. butted. A strip of metal is placed on both sides of the joint and is then riveted. When welded the edges of the base metal are usually bevelled off before being filled in with the welding material.

**Buys Ballot's Law.** A fundamental law in meteorology. In the northern hemisphere, if an observer faces the wind the atmospheric pressure decreases toward his right and increases toward his left. In the southern hemisphere the reverse is the case. This phenomenon is created by the earth's rotation.



## C

**C.** Letter used to denote cargo aircraft. The letter is used as a prefix to the mark number of the aeroplane and denotes its duty; for example, Warwick CI.

**Cabane.** A pyramidal arrangement of struts used for supporting the wings, wing overhang, wing tips, etc., on an aeroplane.

See also PYLON.

**Cadmium.** One of the elements. A silvery-white crystalline metal whose chemical symbol is Cd. Because of its corrosion resistance characteristics it is commonly used as a plating material.

**Calibrate.** To graduate in representative units. Normally used in referring to the correction of the markings on instruments and measuring devices.

**Call Signs.** When it is desired to communicate with an aircraft in flight by radio a code signal or code sign is first sent out to make contact with the particular machine. The message then follows.

The call sign for civil aircraft consists of the nationality and registration marks.

**Calm.** In meteorology this term refers to the absence of appreciable wind. In such conditions smoke rises vertically.

**Calms of Cancer.** The belts of high pressure which lie north of the north-east trade winds and south of the south-east trade winds.

**Calorie.** A thermal unit. The amount of heat required to raise the temperature of one gram of water one degree Centigrade.

252 calories = 1 British Thermal Unit.

See also BRITISH THERMAL UNIT.

**Calorizing.** A protective process for metals. The steel is immersed in a bath of molten aluminium.

Steel so treated stands high temperatures without undue oxidation or deterioration. Another method is for the steel part to be packed in a case containing granulated aluminium, and heat applied externally. This process does not provide a coating of aluminium, but impregnates the aluminium into the base metal.

**Camber.** The term used to denote the curvature of the upper and lower surfaces of an aerofoil.

**Camera Gun.** This is a special type of camera which is used for training pilots and air gunners in the use of the machine gun in the air. The camera is aligned with the gun sights and when the airman has his target in the sights, the trigger is operated. The camera records a picture of the target as seen through the gun sights; no ammunition is used but the airman's ability as a gunner is recorded.

**Camera Obscura.** A method used for estimating the speed of an aircraft. A lens in the roof of a building throws an image of the aircraft on to the screen which is in a dark room.

**Candle-power.** A measure of the light from a source of illumination. A standard candle gives one foot-candle power on a square foot of area, at a distance of one foot.

**Canopy.** The large silk part of a parachute which, when opened, offers a resistance to the descent of the load.

**Cantilever.** The principle used in most monoplanes. The wings are fixed rigidly to the fuselage, which acts as their support without other aids.

**Cantilever Wing.** A wing built on the principle of a cantilever. It has

no external bracing from the fuselage.

**Canvas.** A heavy cloth of plain weave, occasionally referred to as duck.

**Capillary Tubing.** A metal or glass tube of extremely small bore, e.g. the stem of a thermometer or the metallic tubing connecting the sensitive element to the recording mechanism of certain aero-engine cockpit instruments.

**Captive Balloon.** A balloon restrained from free flight by a cable, one end of which is anchored to earth.

**Car.** In an aerostat this is the structure in or suspended from the envelope for carrying engines, crew, passengers, etc.

**Carbon.** One of the elements, whose chemical symbol is C. Carbon has many allotropic forms such as soot, graphite, diamond, etc. It is the chief constituent of most fuels. In the case of petrol the carbon content is approximately 84 per cent.

**Carbon Steel.** This is the name given to a group of iron alloys having carbon as the principal alloying constituent. Low carbon, or mild steel, contains up to 0.25 per cent carbon; medium carbon steel from 0.25 to 0.7 per cent, and high carbon steel from 0.7 to 1.5 per cent. Medium and high carbon steels can be hardened by heating to redness and cooling suddenly in water or oil. Low carbon steels are not much affected by such treatment.

The melting point of carbon steel depends upon the amount of carbon contained, but lies between 1400° C. and 1500° C., the effect of the carbon being to lower the melting point. The low and medium carbon steels can be forged, rolled, and hammer welded, but as the percentage of carbon increases these operations become more difficult.

Young's Modulus of Elasticity for steel is  $29 \times 10^6$  lb. per sq. in.

**Carbonizing.** Impregnation of a metal with carbon.

See also CASE-HARDENING.

**Carborundum.** A trade name for an abrasive compound of silicon and carbon. Owing to its exceptionally hard nature, it is normally used as a grinding agent.

**Carburettor.** A mechanical device for mixing liquid fuel and air in the proper proportions to form a combustible mixture for use in internal combustion engines.

A simple carburettor consists essentially of a small reservoir in which the fuel is maintained at a predetermined level by a float and needle-valve mechanism. The downward movement of the engine piston on the induction stroke causes air to enter the carburettor. The effect of a restriction, or choke in the air intake, is to cause the air to speed up at the narrowest cross-section with a corresponding drop in its pressure. A calibrated jet is placed at this point, and the difference in pressure between the float-chamber and the jet causes fuel to issue and mix with the airstream. The relative sizes of the jet and choke are arranged so that a combustible mixture of fuel and air passes to the engine. (Approximately fifteen parts of air to one of fuel, by weight.) The throttle valve controls the quantity of mixture reaching the cylinders and hence the power of the engine.

In actual carburettors special provision is made for starting-up and slow-running, and in the case of those fitted to aero engines the variation of air density due to altitude.

**Carburettor Air Heater.** A device using the exhaust gas from an engine to increase the temperature of the air entering the carburettor air intake. In order to obtain the

best carburation and to prevent ice formation, the air to the carburettor should be heated to a defined temperature.

**Carburettor Air Scoop.** A special opening of the carburettor air intake which is designed to make sure that an adequate supply of air is available at the carburettor.

**Carburettor Anti-icer.** A system which pumps a small amount of alcohol into the airstream to prevent the formation of ice in the carburettor. Another method of heating the carburettor is to surround it by a jacket containing hot lubricating oil from the engine.

**Carburettor Float.** A cork or light, airtight metal float which is an integral part of the carburettor. It floats in the fuel in such a way that it controls a needle valve, which in turn controls the fuel level in the float chamber.

**Carburizing.** In acetylene welding an oxy-acetylene flame in which there is an excess of acetylene has the effect of carburizing the metal on which it is played.

See also CASE-HARDENING.

**Cardinal Points.** The principal points (north, east, south, and west) of the compass.

**Carnet.** This is a document issued by the Customs authorities enabling the holder to travel abroad with the minimum formalities and without having to deposit custom dues on the aircraft.

**Cartographer.** A person who makes maps and charts.

**Cartridge Starter (Coffman Type).** This is a mechanical device for starting aero engines by giving them a high rotative speed for a few revolutions. A special cartridge is fired electrically in a breech holding five cartridges somewhat in the manner of a revolver. Connected to the breech is a stainless steel tube, known as the combustion tube, of definite volume and in which the

gases resulting from the explosion of the charge burn and build up a high pressure. The other end of the combustion tube connects with a cylinder fitted with a piston which is held at the top of its stroke by a strong spring. Attached to the under side of the piston is a shaft carrying spiral splines which engage in a flanged hub fixed to the housing. The end of the shaft carries teeth to engage with teeth machined in the engine starter jaw assembly. The high-pressure gases from the combustion tube enter the cylinder. The resultant forward movement of the piston pushes the shaft forward to engage the starter jaws, further movement being prevented by a thrust race. Continued piston movement causes the shaft to rotate by the effect of the spiral splines. Thus during the downward movement of the piston the engine is rotated. At the bottom of the stroke an exhaust valve is opened to permit the escape of the burnt gases and the piston is returned to the top of the cylinder by the spring already mentioned.

**C.A.S.** See CHIEF OF THE AIR STAFF.

**Cascades.** Fixed blades which direct the airstream round the bends in the passages of a return flow wind tunnel. They are of aerofoil shape.

**Case-hardening.** This is a treatment to give a low carbon steel a higher carbon content on the surface, the core of the metal being unaffected by the process. The outer skin being then a high carbon steel it can be hardened by heating and quenching in oil or water, while the core remains soft and tough.

The procedure is to carburize the surface of the material by surrounding it in a gas-tight container with a suitable carbonaceous material such as bone, leather, charcoal, or proprietary compound, and to raise the whole to a high temperature for

a given period. The depth of penetration depends upon the carburizing medium, the temperature, and the time taken.

Another method of case-hardening is to use special compounds into which the heated job is dipped. Reheating and dipping should be done three or four times. This process produces a very hard skin, but the depth of penetration is small.

Still another process which produces a hard skin is known as "nitriding." This is carried out at low temperature by placing the article in a sealed tank into which ammonia gas is introduced at a temperature of 500° C. for a period of from 20 to 40 hours. As it is not necessary to quench, merely cooling to room temperature being sufficient, this method avoids distortion and does not cause hardening cracks to develop.

**Casein.** This is a product of skimmed milk. The skimmed milk is heated in a stirring pan and rennet added until a curd forms. The resultant product is then washed, pressed, and partially dried, finally being formed into sheets, rods, etc. It is soaked in a formaldehyde solution which toughens and renders it proof against decomposition.

It is used in the aeronautical plywood industry as an adhesive.

**Casein Glue.** A cold-water glue which can be applied cold as an adhesive for wood. It is produced from skimmed milk, and is used in the aircraft industry.

See also CASEIN.

**Cassini's Projection.** This is a system of projection from the curved earth's surface on to a plane surface, and is used in the preparation of ordnance maps in this country.

**Cast Ingot.** A metal or alloy which has been cast into a suitable

shape so that it may be forged or rolled.

**Cast Iron.** A crystalline, brittle iron which is produced (from pig iron and scrap) in a small furnace known as a "cupola," having a carbon content of from about 2.5 to 6 per cent. It is a particularly good medium from which to make castings, and it also possesses excellent machining qualities, being capable of sustaining a highly finished surface. Too heavy in general for aircraft work, it is very strong in compression but of low tensile strength. Whilst it cannot be forged or rolled it can be fusion welded. The melting point of cast iron is approximately 1100° C.

**Cast Steel.** Steel of high carbon content which is produced in small quantities at a time in a crucible, and therefore sometimes called "crucible steel." The molten steel is poured from the crucible into a mould in the form of an ingot, subsequently being rolled or forged into sheet or bar.

**Casting.** Any material produced from the molten state after being poured into suitable moulds.

See also SAND CASTING; DIE CASTING.

**Castor Oil.** A vegetable oil which is extracted from the seed beans of the castor oil plant. It does not dry on exposure to the atmosphere, and has excellent lubricating properties, but oxidizes much more easily than mineral oils. The earlier types of aero engine used castor oil exclusively as a lubricant.

**Catalytic Agent.** An extra substance which, because of its presence, causes a chemical change to be speeded up; the action occurs with no change in temperature and the catalyst undergoes no permanent change. The action is called "catalytic."

**Catapult.** A mechanical device used for launching an aeroplane by

giving it a greater initial speed than is possible by its own power.

**Catenary.** The curve formed by a chain of uniform density and cross-section, when hanging freely between two points of suspension.

**Catenary Wires.** Wires which form approximately a catenary to collect and transmit loads from other wires in a transverse frame of a rigid airship.

See also CATENARY.

**Caterpillar Club.** The name of a club all of whose members owe their lives to the parachute. This is the only condition of membership. At first sight the name may seem incongruous, but when it is remembered that the canopy is made of silk, the aptness of the title is obvious.

**Cathedral Angle.** The opposite of dihedral angle.

**Cathode.** The conductor through which an electric current leaves an electrolyte when the principle of electrolysis is being applied.

**"C" Battery.** A grid-bias battery (American terminology).

**"C" Certificate (Glider).** This is a licence which is issued for competency for the flying of gliders. It is issued by the Royal Aero Club of the United Kingdom under conditions laid down by the International Aeronautical Federation. There are three classes, A, B, and C, C being the highest category.

Candidates are required to carry out under observation practical tests, in all of which the candidate must be alone in the glider. For Certificate "C" the test comprises a flight of five minutes' duration at a height greater than the point of departure and should end with a normal landing.

**Ceiling.** The ceiling of a cloud is the distance from the cloud base to the ground.

See also ABSOLUTE CEILING; SERVICE CEILING.

**Ceiling Projector.** This type of projector produces an illuminated region on a cloud in order to determine its height.

**Celestial.** A term referring to heavenly bodies or to the sky.

**Cell.** An arrangement of a number of electrodes or plates in an electrolyte.

**Cellophane.** A trade name for a thin, flexible transparent material which is made from cellulose.

**Celluloid.** A moulded material consisting of nitro-cellulose which has been treated with camphor in order to reduce its inflammability and increase its flexibility.

**Cellulose Acetate.** A plastic material employed for moulding. Used for the making of photographic films, lacquers, etc. It is manufactured from cellulose and acetic acid.

**Cellulose Plastics.** This is the name given to a group of synthetic resins, derived from wood pulp, paper pulp, or cotton, used in the plastics industry and comprising cellulose acetate, cellulose nitrate, and benzyl cellulose. They are known as "thermo-plastic" because they flow when heated to a temperature of about 200° F., "set" when cooled, but can be made plastic again on reheating.

Before moulding to their final shape they are mixed with a "filler," e.g. china clay, wood flour, cotton, asbestos, etc., which supplies the necessary strength, the plastic merely acting as a binder.

**Cementite.** This is the name given to a chemical compound of iron and carbon called iron carbide ( $\text{Fe}_3\text{C}$ ) which is found in carbon steel. Cementite is hard and brittle and at temperatures above 700° C. is in solid solution in the pure iron. When the steel is annealed the cementite is precipitated from the solid solution, and the microstructure consists of crystals of pure iron

(ferrite) and cementite, producing a steel in the soft condition. When the steel is quenched in water or oil from a red heat the cementite, which at high temperature is in solid solution and thus uniformly dispersed, tends to be trapped in this condition and thus the phenomenon of hardness is produced.

**Centigrade Heat Unit.** See CALORIE.

**Centigrade Scale.** A scale on which, under standard atmospheric pressure, 0° denotes the temperature of melting ice, and 100° the temperature of boiling water.

**Centimetre.** A metric unit of measurement equal to one-hundredth of a metre. It equals 0.39 of an inch.

**Centre Line.** A technical term denoting a line from which all transverse dimensions are taken; it may refer to the centre line of a drawing or of an actual structure.

**Centre of Buoyancy.** The point at which the total upward thrust due to displaced fluid is assumed to be acting. In the case of aerostats the centre of buoyancy must lie in the same vertical plane and above the centre of gravity of the whole structure to produce a state of equilibrium. For bodies floating in water the same conditions apply.

**Centre of Gravity.** The point about which a body would balance in any position. For purposes of calculation the whole weight of a body may be assumed to act at its centre of gravity.

**Centre of Lift.** The point at which the resultant of all the centres of pressure of an aerofoil acts.

**Centre of Pressure.** That point on the chord line of an aerofoil where the resultant of all air forces along the chord may be assumed to act.

**Centre Section.** The centre portion of the main plane of an aeroplane which is mounted rigidly

on the fuselage. The port and starboard main planes are attached to this section.

**Centrifugal Force.** If a body is constrained to move in a circle it would, if released, travel in a tangential direction; therefore, to keep it in its circular path a force acting inwards towards the centre of rotation must act on the body. This inward force acting on the body is called the "centripetal force."

It should be noted that there is no outward force on the body. To clarify this, imagine a body being turned round in a circle at the end of a string; then the inward pull of the string will supply the centripetal force, but the body exerts an equal and opposite pull on the string and the string pulls at the centre of the circle. This outward pull is called the centrifugal force.

Numerically the centrifugal (or centripetal) force can be found from the formula—

$$\text{C.F.} = \frac{Wv^2}{gr} \text{ lb.}$$

where  $W$  is the weight of the body in pounds,  $v$  its speed in feet per second,  $g = 32.2$ , and  $r$  the radius of gyration in feet.

**Centrifugal Supercharger.** This is a device fitted to modern aero engines to deliver air or air/fuel mixture to the cylinders at a predetermined pressure called the boost pressure.

The centrifugal supercharger consists essentially of an impeller having a number of radial vanes and rotated at high speed in a suitable housing. The fluid enters the vanes at their roots and leaves at their tips, having been given a high velocity as a consequence. Placed round the periphery of the impeller and rigidly fixed to the housing are a series of curved blades forming what is called the diffuser or deflector. The high velocity fluid

after leaving the impeller passes through the fixed blades where its velocity energy is changed into pressure energy before being delivered to the engine cylinders.

**Centripetal Force.** The force which acts on a body moving in a curved path and keeps the body from moving at a tangent or in a straight path.

See also CENTRIFUGAL FORCE.

**Certificate of Airworthiness.** A certificate which is issued when an aircraft and its engine comply with the prescribed regulations.

**Chain Riveting.** A form of double riveting, where the two lines of rivets are directly opposite one another instead of being arranged diagonally, as in zigzag or staggered riveting, where all the rivets in one line are directly opposite the centre of the spaces between the rivets in the other line.

**Charts.** A chart may be defined as a representation to scale of the surface of the earth, and usually shows a greater proportion of water than land, as contrasted with a map, which normally shows more land than water. Charts are produced specifically for the use of the mariner and for air navigators of flying boats or other oversea aircraft. Normally they are made on Mercator's projection.

**Chassis.** See UNDERCARRIAGE.

**Chief of the Air Staff.** A member of the Air Council who is responsible for planning, operations, tactics, and intelligence.

**Chili.** This is the name given to a hot, dry, southerly wind which occurs in Tunis. Similar to the sirocco.

**Chine.** The extreme side member of a flying boat hull which runs approximately parallel to the keel in side elevation.

**Chine Angle Plate.** A length of angle plate running fore and aft, which forms a means of attachment

of the side shell plating to the planing bottom, being riveted to both. That fitted outboard is known as the "outer chine angle plate," and that fitted inboard as the "inner chine angle plate."

**Chine Angle Step.** An angle plate developed to conform to the chine at the step, and fitting over the step portion of the chine of a hull.

**Chinook.** A warm, dry, west wind occurring on the eastern side of the Rocky Mountains in Canada.

**Chocks.** Shaped blocks which are used to prevent the forward movement of an aircraft. They are normally placed in front of the undercarriage wheels.

**Chord.** The curvature of the upper and lower surfaces of an aerofoil are plotted from a reference base line from given co-ordinates. In the case of an aerofoil having convex curvature on both the upper and lower surfaces, the chord is a straight line joining the most forward point of the leading edge to the rearmost point of the trailing edge. When the aerofoil has a sensibly flat lower surface the chord is the line that coincides for the most of its length with the under surface. The chord length is the length of the projection of the aerofoil section on its chord.

When used in connexion with the aspect ratio of a tapered wing, the chord taken is the average chord.

**Chord Wiring.** In aerostats the system of wires which interconnects the joints of a main transverse frame.

**Chromate Treatment.** A treatment for protecting magnesium alloy castings against corrosion. The part is immersed for several hours in a boiling solution containing potassium and ammonium dichromate. Generally a coating of cellulose enamel is applied subsequently as additional protection.

**Circloip.** A spring ring which

locates and prevents the end-wise movement of a rotating or oscillating pin.

**Circumferential Gas Bag Wires.** The circumferential wires fitted inside the longitudinals of an aerostat and placed to take the pressure of the gas bags.

**Circumferential Outer Cover Wires.** The circumferential wires in an aerostat fitted outside or inside the longitudinals to which the outer cover is attached.

**Cirro-cumulus.** A layer of cloud which is composed of small white tufts without shadows. They are often arranged in groups or lines.

**Cirro-stratus.** A thin veil of whitish cloud sometimes covering the whole sky through which the sun or moon is visible. Haloes are seen with this cloud occasionally.

**Cirrus.** Isolated clouds of delicate fibrous texture usually in wisps or bands without shadows.

**Civil Air Ensign.** By an Order in Council issued on the 11th August, 1931, a Civil Air Ensign was established. It may be flown by British aircraft registered in the United Kingdom, at licensed airfields in the United Kingdom and on buildings used by British Air Transport Companies.

The Ensign is of light blue (Royal Air Force blue) with a dark blue cross edged with white; in the first quarter is the Union Jack.

**Clear Ice.** Ice which under normal conditions is smooth and glassy but which when it forms on an aircraft in the presence of sleet and snow becomes very rough and accumulates in an irregular mass near the leading edges of wings and control surfaces. It adheres tightly to the surfaces, is nearly impossible to remove, and causes deformation of the wing camber, with consequent loss of lift.

**"C" Licence (Ground Engineers).** A certificate issued to persons over

the age of 21 who may be of either sex, who have had satisfactory practical experience and passed an examination on the inspection of engines before flight. Licences are valid for one year at a fee of 21s., and may be renewed at a fee of 5s. on evidence of recent practical experience in the duties covered by the licence.

**Climate.** The weather conditions over a considerable period of time and involving a relatively large area of the earth; e.g. Britain is said to have a temperate climate, meaning that over this portion of the earth's surface there are no extremes of heat or cold.

**Climatology.** In meteorology this is the study of the climatic conditions on the earth's surface.

**Climbing Shaft.** A shaft through the interior of an airship through which personnel can ascend to the top of the envelope.

**Climbing Turn.** A flying manoeuvre which consists of making a climb while the aeroplane is turning.

**Clockwise.** Rotation about a point, in the direction as indicated by the movements of the hands of a clock. When applied to propellers the direction of rotation is always viewed from behind, i.e. as if the observer were standing on the engine looking at the propeller.

**Closed Jet Wind Tunnel.** A wind tunnel in which the aerofoil or object under test is placed within the structure itself, and the fluid stream is entirely enclosed as it passes through the tunnel and over the body being tested.

**Cloud, Amount of.** The proportion of sky obscured by cloud. Generally expressed in tenths of sky covered, e.g. cloud, three-tenths.

**Cloud Burst.** A sudden and exceptionally heavy downpour of rain.

**Cloud Cap.** A cap-like cloud covering the top of either a mountain or another cloud.



**Cloud Height.** The height of the base of the cloud above the ground.

**Clouds.** See HIGH CLOUDS (CIRRUS; CIRRO-CUMULUS; CIRRO-STRATUS); MEDIUM CLOUDS (ALTO-CUMULUS; ALTO-STRATUS); LOW CLOUDS (STRATO-CUMULUS; STRATUS; NIMBO-STRATUS); VERTICAL STRUCTURE CLOUDS (CUMULUS; CUMULO-NIMBUS).

**Coamings.** A term used in hull construction. It denotes the vertical linings to cockpits, hatchways, and other openings in the decks.

**Cockpit.** In the earlier types of aircraft the parts for the accommodation of the pilot and passenger were referred to as cockpits. The term is now almost universally applied only to the portion of the aircraft occupied by the pilot when at the controls.

**Cockpit Lamp.** A lamp (or lamps) for illuminating the cockpit.

**Code Light.** An intermittent light having dark and light periods by which it can be recognized.

**Coefficient.** Term used in engineering to denote a ratio of two quantities or a degree of electrical action. In algebra the term indicates a constant number placed before a letter or letters denoting value.

**Coercive Force.** When iron is demagnetized it is found that the entire magnetism is not lost. In order completely to demagnetize the iron it is necessary to apply a reversed magnetic field to coerce or lose its remaining magnetism.

**C. of A.** See CERTIFICATE OF AIRWORTHINESS.

**Coffman Starter.** See CARTRIDGE STARTER.

**Col.** A term used in meteorology to indicate a pressure area separating two anticyclones or two depressions.

**Cold Air Mass.** An air mass that is cold relative to neighbouring air masses. The term suggests that the

air mass originated in higher latitudes and that it is colder than the surface over which it is passing.

**Cold Front.** This denotes the forward boundary of advancing colder air which is overtaking (and under-running) warmer air. The passage of a typical cold front is associated with a relatively short period of heavy rain and perhaps squalls or thunderstorms. In the rear of the front there is detached (cumulus type) cloud, often with showers.

**Cold-rolled Steel.** A low carbon, open-hearth steel which has been rolled at atmospheric temperatures into sheets, strips, or bars. The rolling operation hardens the steel, increasing with the extent of rolling. A tensile strength of 54,000 lb. per sq. in. is obtainable by cold-rolling.

**Cold-working.** Working by any process a metal at atmospheric temperatures. The results are an increase in strength and hardness with a decrease in toughness and ductility.

**Collapsible Aerial.** This is normally carried by a rigid arm fixed to the aircraft and may be elevated or retracted by the pilot or a member of the aircrew.

See also AERIAL.

**Collector Ring.** An exhaust system used on a radial engine which consists of short pipes leading into a common circular exhaust manifold.

**Columbium.** A metallic element, chemical symbol Cb. Sometimes used as a stabilizing agent for stainless steel.

**Combustion.** The combining of one or more elements with oxygen. In the case of an internal combustion engine the fuel consists essentially of carbon and hydrogen, and during the combustion within the engine cylinder the carbon content combines with the oxygen in the air and forms carbon dioxide and possibly carbon monoxide, whilst

the hydrogen burns to water vapour. During this process heat is liberated and is utilized to do work on the pistons.

Corrosion is also a form of slow combustion; thus rust on iron is produced by the chemical combination of the iron and oxygen, resulting in the formation of iron oxide.

**Combustion Chamber.** The volume in an engine cylinder above the piston head when the piston is at top dead centre. The capacity of the combustion chamber influences the compression ratio, whilst its shape can affect the efficiency of the fuel combustion.

**Combustion Starter.** A device for starting up aero engines by generating a gas pressure by combustion. The high pressure products of combustion are introduced into one or more cylinders of the engine at the correct point in the cycle, driving the pistons downward and thus causing the engine to rotate.

See also CARTRIDGE STARTER.

**Commercial Brass.** A brass which contains approximately 90 per cent copper and 10 per cent zinc.

**Compass.** An instrument which utilizes a freely suspended magnetic needle, or group of needles, to indicate direction. The needles are sometimes attached to the underside of a light circular card, the circumference of which is divided into 360 degrees and marked with the cardinal points.

For use in aircraft special provision is made to damp out oscillation by suspending the magnets in a container filled with liquid.

**Compass Base.** An area which is provided with means for orientating aircraft for the purpose of adjusting compasses.

**Compass Card.** A component of a compass attached to, and swinging with, the magnetic needles. Generally made of mica, it carries a

circular scale of 360 degrees on which the cardinal points are marked.

**Compass Compensation.** This is accomplished by the use of small magnets so located relative to the compass that they cause corrective forces which leave the compass needle comparatively free from the magnetic influence of the metal parts of the aircraft.

See also DEVIATION.

**Compass Course.** The bearing as indicated by the angle between the compass needle and the direction of flight of the aircraft. A compass course is equal to a true course  $\pm$  variation and  $\pm$  deviation; also a compass course is equal to a magnetic course  $\pm$  deviation.

**Compass Points.** The thirty-two divisions into which the circumference of a compass card is divided. The "cardinal" points are north, east, south, and west, and each space is divided into eight equal parts.

See also BOXING THE COMPASS.

**Compass Swinging.** See DEVIATION.

**Compensating Magnets.** Small magnets used for the correction of the compass deviation.

See also COMPASS COMPENSATION; DEVIATION.

**Compensating Sights.** Gun and bomb sights so designed that the relative motion of the aircraft and the target is taken into consideration.

**Composite Aircraft.** This is a type of aircraft such as the Mayo in which a small aircraft is superimposed on a large aircraft of high lift. Both machines are taken into the air fixed together, and at a predetermined height the smaller one is disengaged to carry on with its flight.

The term is also applied to aircraft whose structural members are constructed partly of metal and partly of wood.

**Composite Cooling.** See EVAPORATIVE COOLING.

**Compressed Air Starter.** A device used for starting an engine by utilizing the expansion of compressed air. The compressed air is stored in the aircraft in metal bottles generally charged from an engine-driven compressor and conveyed to the engine cylinders by pipes through a suitable valve situated in the pilot's cockpit.

**Compressed Air Wind Tunnel.** A wind tunnel in which the pressure and density of the air can be substantially increased above that of the atmosphere. Essentially it consists of an outer steel shell entirely enclosing the tunnel proper. The air, after being drawn through the tunnel, past the model under test, is returned between the outside of the tunnel and the steel shell to its starting point, thus maintaining a constant flow. It is possible to raise the pressure of the air because it is totally enclosed.

See also REYNOLDS' NUMBER.

**Compression.** The result of two forces having the same line of action and acting toward each other. In the case of a rigid body under the action of compressive forces, the material will tend to be crushed and a compressive stress will be set up in the material. When dealing with gases, say within an engine cylinder, the effect of compression is to reduce the volume materially, raise the pressure, and increase the temperature.

**Compression Ratio.** The ratio of the volume of the space in an engine cylinder above the piston when it is at the bottom of its stroke and when it is at the top of its stroke, i.e.

$$\frac{(\text{Piston swept volume}) + (\text{Volume of combustion chamber})}{(\text{Volume of combustion chamber})}$$

For petrol engines this ratio varies between 5 and 7 to 1 and for

compression-ignition engines from about 12 to 16:1.

The compression ratio plays an important part in the thermal efficiency obtainable from an internal combustion engine. The higher the compression ratio, the higher the thermal efficiency. There are, however, practical limitations to the compression ratio which can be utilized.

**Compression Rib.** A wing rib which is built to take compression loads.

**Compression-ignition Engine.** A type of internal combustion engine in which the fuel is injected into the combustion chamber and ignited by the heat produced due to the compression.

The cycle of operations is somewhat similar to that of the petrol engine and is as follows. Air, only, is taken into the cylinder during the induction stroke, and is then compressed under a high compression ratio. Just before the top of the compression stroke a charge of fuel is sprayed into the combustion chamber and, meeting the high temperature air, immediately ignites, forcing the piston down on the working stroke. The next upward stroke expels the exhaust gases from the cylinder. In modern practice it is usual to refer to the lighter, high-speed type of engine as a compression-ignition engine as distinct from a Diesel engine. Though both types are essentially "compression-ignition," the former works on a composite constant volume/constant pressure cycle, whilst the latter operates on the constant pressure cycle.

See also DIESEL ENGINE.

**Compressive Stress.** When exter-

nal loads act on a member tending to crush it or, in the case of a strut,

shorten its length, the material of the member is said to be under a compressive stress. In a beam under load one of its surfaces is in tension whilst the opposite surface is in compression. The portion of the beam in compression is under a compressive stress.

When a strut is carrying an axial compressive force the compressive stress induced in the material is numerically equal to the compressive force divided by the cross-sectional area of the strut, and is expressed in pounds or tons per square inch.

**Comrades of the Royal Air Force.**

An association whose aim is the linking together of all who served or are serving in any branch of the British Air Forces. Social gatherings are arranged as well as visits to places of interest.

**Concave.** A hollow or cup-shaped depression.

**Concentric.** Having a common centre.

**Condensation.** When a vapour is cooled a temperature is reached at which it changes state and condenses in the form of a liquid. Apart from the engineering aspect, a common example occurs in the atmosphere. When the air is warm it can contain a considerable amount of water vapour in an invisible form, but when the air becomes cooled it is not capable of holding so much vapour, and consequently the surplus condenses out and droplets of water are formed which may appear as cloud or dew.

**Conduction.** When one portion of a body is at a higher temperature than another, heat will "flow" from the former to the latter from molecule to molecule. The same effect can be obtained by a hot body actually touching a cooler one. When heat is transmitted in this way it is referred to as conduction. A good example of heat conduction

occurs in the case of the cylinder of an internal combustion engine. The inside walls in contact with the hot products of combustion have their temperature raised relative to the outside of the cylinder in contact with the coolant. Consequently there is a constant flow of heat from the inside to the outside, through the metal.

The quantity of heat conducted depends upon the metal under consideration, the area, the difference in temperature between the hot point and the cool point, and the time.

**Conductivity.** The ability of materials to transmit electrical current, heat, etc.

**Cone of Silence.** A small area above a transmitting station within which the signal suddenly dies out. The cone of silence has its point located at the transmitting station. The area of the cone of silence increases as the altitude is increased.

**Conic Section.** The geometrical curve which is formed by the intersection of a plane surface with a right circular cone, being an ellipse, parabola, or hyperbola.

**Connecting-rod.** That part of an engine which connects the piston to the crankshaft and thus enables the reciprocating motion of the piston to be converted into rotary motion at the crankshaft. The end which is connected to the piston by the gudgeon pin is known as the "small end," whilst that attached to the crank pin is called the "big end."

**Connecting-rod Assembly.** The assembly of two or more connecting-rods which work on one crank pin.

**Connecting-rod, Master and Articulated Assembly.** An assembly of connecting-rods in which the big end of the master connecting-rod carries the articulated rods which oscillate on wrist pins held in flanges or lugs of the master connecting-rod.

**Constant Speed Propeller.** A propeller which automatically maintains a constant speed. It does not increase its revolutions per minute in dives, or decrease them in climbs, i.e. the power is constant. The general principle of a constant speed propeller is that whenever the speed of the propeller tends to increase, the pitch angle of the blades is increased, and vice versa. Constant speed propellers increase the performance of an aeroplane because maximum horse-power and thrust are maintained at all times.

There are two main types, viz. those whose blade angle is adjusted hydraulically and the all-electric variety. The control mechanism in each case is a centrifugal governor which either actuates a valve admitting oil under pressure to a piston, or operates electrical switches. The pilot can select the desired revolutions per minute by a control in the cockpit.

**Consumption.** The total quantity of fuel or oil consumed, normally stated in gallons or pints per hour, or in gallons or pints per brake horse-power per hour. A typical figure for a modern aero engine under economical cruising conditions is 0.54 pint per b.h.p. per hour.

**"Contact."** This is the term used to denote that the magneto-earthing switch in the pilot's cockpit is in the "on" position for starting up the engine. When this switch is "on" the contacts are separated.

**Contact Breaker.** A device, automatic in operation, for opening and closing a circuit. The contact breaker in the primary circuit of a magneto is a device of this kind.

**Continuous Weld.** A weld that is continuous from the beginning of a joint to the end in contradistinction to spot welding.

**Contour Lines.** Lines on a map which are drawn through points of

the same altitude above sea level. By studying the contour lines on a map it is a simple matter to determine the gradients of roads, etc. E.g. if the lines are close together the gradient is steep, whilst if they are widely separated the slope is gradual.

**Contour Maps.** Maps upon which the varying heights of hills and mountains are represented by contour lines. The heights may also be indicated by conventional hatching or colour.

**Control Car.** The car of an airship in which the controls are situated and from which the airship is operated.

**Control Column.** A lever for operating the longitudinal and lateral control surfaces of aeroplanes. The elevator is operated by a fore-and-aft movement of the lever, the ailerons by rotation of a wheel or by side movement if it is a control stick. The mechanism between the control column and control surfaces is so contrived that the instinctive movement of the former by the pilot positions the aircraft accordingly, e.g. when the "stick" is pushed forward the aircraft will descend, and when the stick is pulled back it will climb. Similarly for banking, a movement to the right will cause the left, or port, wing to rise, and vice versa.

**Control Surface.** A movable aerofoil designed to be moved by the pilot in order to change the attitude of the aircraft, e.g. ailerons, rudder.

**Controllability.** The quality of an aircraft which determines its ease of operation.

**Controllable Pitch Propeller.** A propeller which has a means of controlling the angle of pitch of the blades in flight. The control may be operated either directly by the pilot or automatically by the use of electrical or oil-pressure operated devices. A controllable pitch pro-

PELLER can be set at the most efficient angle of pitch for all speeds and engine conditions.

**Controls.** A generic term applied to the means provided to enable the pilot to control all conditions of flight of the aircraft.

**Convection.** Convection is one method of transferring heat to a fluid. Consider, for example, a vessel containing water which is being heated. The water touching the hottest part of the vessel will expand, thus becoming less dense, and will rise, its place being taken by the colder water which has been displaced. In this way "convection currents" are set up within the liquid, the hotter portions rising and the cooler descending, which will continue so long as a difference of temperature exists. Convection currents are, of course, to be found in the atmosphere, and great use is made of them by glider pilots.

**Conversion Angle.** Term employed in directional wireless to denote the angle between the great circle and the rhumb line.

**Coolant.** A cooling medium used in an internal combustion engine; it may be air or liquid. A good liquid coolant should possess the following characteristics: (i) high boiling point, (ii) high specific heat, (iii) low freezing point, (iv) non-corrosive properties, (v) low cost. Moreover, if it contains two or more substances, it should not disintegrate or deteriorate under working conditions.

Pure glycol or a mixture of glycol and water are commonly used in aero engines as coolants.

**Copal.** Used for making varnishes, primers, and lacquers. It is obtained from fossil resins found in most tropical countries.

**Copper.** One of the elements, its chemical symbol being Cu. It is a good conductor of heat and electricity, and is used extensively for

electrical parts. Copper is the base metal alloyed with zinc to form brass and with tin to form bronze. It is ductile, malleable, and tenacious.

**Core.** The inner part of anything, for example, the inside portion of case-hardened steel in which the carbon content has not been substantially increased.

**Corridors.** Points at which aircraft must cross national frontiers, being defined in order to assist Customs supervision. There are usually airports at both ends of a corridor.

**Corrosion.** Corrosion is the term used to describe the result of chemical action which takes place on the surface or within the structure of most metals when in the presence of air, moisture, salt-water, acids, etc., or when subjected to high temperatures. In the case of ferrous metals it is apparent in the form of rust, in aluminium and its alloys as a white grey powder, in copper as the green verdigris, and the effect is to eat away the sound metal, thus reducing its structural strength. Intercrystalline corrosion occasionally occurs in light alloys and certain types of stainless steel. This type is difficult to detect as only minute cracks are visible, but these penetrate through the metallic structure of the metal, causing weakness which may result in the failure of the part.

Another source of corrosion is the galvanic action set up at the junction of two dissimilar metals.

**Corrosion-resisting Steel.** A group of steel alloys containing chromium and nickel which, because of their resistance to corrosion, are referred to as "stainless steels." The following are the chief classes—

(i) **Stainless Steel.** This contains from 12 to 14 per cent chromium and about 0.2 per cent carbon. Tensile strength about 30 tons per

sq. in. Used for tanks, rivets, nuts, bolts, golf clubs, etc.

(ii) **High Chromium Stainless Steel.** This contains from 12 to 20 per cent chromium, 0.3 per cent carbon, and a small percentage of nickel. Tensile strength comparable with that of high-grade alloy steels and used where there is a likelihood of corrosion.

(iii) **Austenitic Stainless Steel.** This class resists corrosion better than the high chromium stainless steels, and contains from 12 to 18 per cent chromium and 8 to 12 per cent nickel. It is non-magnetic, very tough and difficult to machine. Tensile strength 60 tons per sq. in. As its internal structure is not impaired by working under conditions of high temperature, it is used extensively for aero-engine exhaust valves.

**Coslettizing.** This is a process used to produce an anti-corrosive coating on steel. The part must first be roughened by sand-blasting, and all traces of grease removed, then it is immersed in Coslett solution for two and a half hours. After rinsing in boiling water and thoroughly drying in an oven if necessary, all surplus deposit is brushed off with a stiff brush whilst still hot. The final operation consists of immersing the hot article in mineral lubricating oil.

**Counter-clockwise.** Rotation in a direction opposite to that of the hands of a clock.

**Countersink.** Removing material near the end of a hole so that the heads of rivets, bolts and screws may be flush with the surface.

**Countersunk Flat Head Rivet.** A rivet used in parts where the heads must be flush with the surface.

**Course.** Any direction in which an aeroplane travels relative to some reference line. A course may be (i) a true course, (ii) a magnetic course, or (iii) a compass course.

A true course is the angle between

the true meridian and the aircraft heading. This course is known as the "track," and is the line on the ground over which the aircraft will fly when due allowance has been made for the wind, for variation, and for deviation.

The magnetic course is the angle the aeroplane's heading makes with the magnetic meridian.

The compass course is the angle between the compass needle and the longitudinal axis of the machine, and is the course steered by compass when the different factors affecting it have been allowed for.

**Course and Drift Indicator.** See BEARING PLATE.

**Course Corrections.** (a) Compass course to magnetic course; add easterly, subtract westerly, deviation.

(b) Compass course to true course; add easterly, subtract westerly, variation and deviation.

(c) Magnetic course to true course; add easterly, subtract westerly, variation.

(d) Magnetic course to compass course; subtract easterly, add westerly, deviation.

(e) True course to magnetic course; subtract easterly, add westerly, variation.

(f) True course to compass course; subtract easterly, add westerly, variation and deviation.

**Course Setting Bombsight.** An instrument which determines for any desired direction the course the aircraft should follow immediately prior to the release of a bomb.

**Cowling.** A removable sheet-metal covering which streamlines and protects the engine, or covers a portion of the fuselage or other parts of an aeroplane.

**Crabbing.** Heading the nose of the aeroplane into a cross-wind by the use of the rudder. This is necessary to prevent the wind from drifting the machine off its course.

The aeroplane moves sideways relative to the ground.

**Crabpot Valve.** A valve in the form of a fabric sleeve in an aerostat, the operation of which is controlled by a hand-line.

**Cracked Spirit.** Originally motor spirit was obtained only by direct distillation from crude petroleum. It was subsequently discovered that the hydrocarbon molecule was unstable under conditions of high temperature, and a process was developed which allowed the heavier fractions which were not usable for petrol engines to be treated in special stills at high pressure and temperature. Under this condition the hydrocarbon molecules are disrupted or "cracked," and form a lighter spirit than the original which entered the still, and also a heavier fraction than the original. The lighter spirit so obtained is termed "cracked spirit," and is quite suitable as a fuel for petrol engines, being particularly good from an anti-detonation standpoint.

The introduction of the cracking process in the manufacture of motor spirit has materially increased the yield of light, volatile fractions per ton of crude petroleum.

**Crankcase.** - The casing of an engine which contains the crankshaft. It provides protection for the big end against damage, dirt, and dust.

**Crankcase Sump.** That portion of a crankcase in which lubricating oil is collected. In some types of engine the crankcase acts as a reservoir for the lubricating oil, in others it is known as the "dry-sump." The oil collects in a specially arranged cavity in the crankcase, whence it is drawn off by the scavenge pump to the cooler, etc.

**Crankshaft.** The main rotating member of an engine which is rotated by the reciprocating motion of the pistons via the connecting-rods.

**Crankshaft Maneton.** The detachable short end of a crankshaft in a rotary or radial engine. It consists of a crank-web integral with a short length of shafting, and is attached to the main shaft at the crank pin.

**Crash.** A colloquial term which refers to any accident caused to an aircraft by its coming into heavy contact with the earth.

**Creep Stress.** The minimum stress that when applied to any crystalline metallic material at a particular temperature will produce a definite elongation after a period of time.

**Cristofin Covering.** This is a polyvinyl enamel which is applied by brush to wooden propellers. The preliminary coats are of a slightly different mixture to ensure complete adhesion to the timber.

**Critical Altitude.** The maximum altitude at which a supercharger can maintain in the intake manifold of an engine a pressure equal to that existing during normal operation at rated power and revolutions per minute at sea level.

**Critical Angle of Attack.** The angle of attack at which the airflow pattern over a given aerofoil changes suddenly. It is the angle of attack at which maximum lift occurs, and any increase in this angle will result in a sudden loss of lift.

See also **BURBLE POINT.**

**Critical Speed.** The minimum forward speed at which an aeroplane can sustain itself in the air and be under full control.

In the case of an engine the critical speed is that speed of the crankshaft at which excessive vibration is set up. If the speed is increased beyond this point the vibration generally disappears.

**Critical Temperature.** The temperature at which changes in the internal structure of metals occur. For example, when steel is being heated from room temperature to a



bright red condition there are points where the temperature does not rise for a short period in spite of the constant application of heat. These periods, in this case, are called "critical points." When the steel is cooled the process is reversed, i.e. the temperature does not fall uniformly but at the critical points remains steady for a short time. If the heating and cooling are carried out slowly the corresponding points on heating and on cooling may be coincident, but in practice, however, the critical points on heating are higher than those on cooling. A knowledge of these critical temperatures is important in connexion with the heat-treatment of steel.

In the case of non-ferrous metals and alloys the critical temperature generally refers to a temperature above which the metal must never be heated, otherwise its properties will be destroyed.

**Cross-bracing.** Wires, cables, or girders in the form of a cross which are incorporated in a structure to maintain its rigidity.

**Cross-country Flying.** Flying an aeroplane from one location to another, usually over distances great enough from the point of take-off to require air navigation.

**Cross-hatching.** In an engineer's drawing, the method of representing different materials of a structure by means of lines drawn at 45 degrees.

Cross-hatching is also used to denote a sectioned drawing.

**Cross-level.** An instrument used on aeroplanes to give an indication of the angle between the lateral axis and the horizontal, sometimes called a lateral clinometer.

**Cross-section.** A drawing showing the internal structure of an object as it would appear if a cutter were passed through it, cutting the object in sections. The various component materials are differentiated by cross-hatching.

**Cross-wind.** A wind which blows across the direction of the take-off or flight path of an aircraft.

**Cross-wind Landing.** A landing made in any other direction than parallel to the direction of the wind. If the wind is strong the aeroplane must be banked, but at the instant of ground contact it must be aligned with the direction of forward travel.

**Cross-wind Take-off.** The condition of taking an aeroplane off the ground when the direction of the wind is not parallel to the flight path.

**Crucible Steel.** Steel produced by the use of a crucible. The process consists of refining iron scrap, blister steel, and wrought iron by melting in a graphite crucible and adding proper elements and suitable fluxes. The slag is removed and the metal cast into ingots. The crucible process produces a highly refined, high carbon steel suitable for tools. The steel is generally called "cast steel."

**Cruciform Girder.** A structure consisting of vertical and horizontal girders arranged in the manner of a cross.

**Crude Oil.** Crude oil is the colloquial term used to describe crude petroleum as it comes from the oil well. It is a dark viscous oil consisting of a heterogeneous collection of hydrocarbon fractions of varying density and volatility. By a process of distillation the various fractions are separated, the lighter, more volatile fractions such as ether, pentane, etc., coming over at the lower temperatures followed in succession by petrol, kerosene, gas oils, light and heavy lubricating oils, boiler fuel oil, the final residue being a black tar-like substance suitable for use in road making. An additional supply of motor spirit is obtained by submitting the heavier, less volatile fractions to a process known as "cracking."

**Cruising Altitude.** A cruising altitude is that proposed for a flight from point to point during which a constant altitude will be maintained. It is measured in feet above sea level.

**Cruising Horse-power.** An aero engine is not always operated at its maximum power output because conditions during flight and take-off vary considerably, and to run the engine all-out all the time, apart from being unnecessary, would shorten its life and be most wasteful of fuel.

When an aircraft is making a flight where time is not an important factor it is possible to reduce materially the horse-power developed by the engines by reducing the boost pressure and revolutions per minute, as well as to weaken the mixture strength, i.e. the air/fuel ratio.

Engine manufacturers, as a result of data obtained during tests, lay down the conditions of operation under cruising conditions. The best conditions for economical cruising will depend upon the aerodynamic characteristics of the aircraft, but will generally be about 30 per cent of the maximum engine power output in the case of light aeroplanes, and from 40 to 60 per cent for the larger, heavier types.

**Cruising Radius.** The distance an aeroplane can travel before it is necessary to refuel. It is usual to have a reserve fuel supply of approximately 25 per cent of the total fuel capacity.

**Cumulo-nimbus.** Rain clouds which are accompanied by violent air currents. The typical cumulo-nimbus cloud appears as heavy masses of clouds rising from their bases to great heights. The base of these clouds is similar to nimbus, whilst the top is broken and has the appearance of being drawn out in wisps. The average altitude of the base is 4000 to 5000 ft.

**Cumulus.** Puffy or piled-up type clouds having flat bases and cauliflower-shaped tops. The height varies from about 2000 ft. at the base to about 15,000 ft. or even 25,000 ft. at the top.

**Curtain.** A non-gas-tight partition which is fitted within an aerostat, somewhat in the manner of a bulkhead.

**Curtiss Electric Propeller.** This is an aircraft propeller whose blade angles can be altered during flight. It has either hollow steel or aluminium alloy blades carried in a steel hub. A series-wound electric motor, having a double field winding to make it reversible, controls the blade angles through a two-stage epicyclic reduction gear. The control wiring circuits are so arranged that the angle of the blades can be increased or decreased either automatically through centrifugal governor controlled contacts, or manually. There is also a switch which when operated causes the blades to move into the full-feathered position. This type of propeller is often called a controllable pitch or variable pitch propeller.

**Cut Out.** (i) An engine is said to cut out if it misfires or temporarily loses revolutions, and also when it has ceased to fire on all cylinders.

(ii) The term is sometimes used to describe the slow-running cut-off device incorporated in certain aero carburettors, which is designed to prevent a hot engine continuing to run for a few revolutions after it has been switched off. The cut-off consists essentially of a small plunger manually operated by the pilot and placed in the "slow running" system of the carburettor. When it is actuated it blocks up the slow-running mixture passage, thus completely cutting off all fuel supply to the engine.

**Cut Out (Electric).** This is the

name given to an electromagnetic switch which disconnects the generator from the battery it is charging when the voltage from the former falls below a certain minimum value, and connects them again when the voltage has risen sufficiently. It consists of a soft iron core round which is wound a shunt coil, connected across the dynamo output terminals, and a series coil in the main charging circuit. Adjacent to one end of this iron core but held clear by a spring is a soft iron armature carrying one of the contact points. With the increase of speed of the generator its output voltage also increases until such a value is reached that the iron core has become a sufficiently strong magnet to overcome the tension of the spring and to attract the armature, thus closing the contacts. When this happens the charging current is delivered to the batteries, and the magnetizing effect of the series coil further assists in keeping the contacts closed.

If the generator speed falls again until the voltage is too low to charge the battery, the latter will begin to discharge, causing a reversed current to flow through the cut-out series coil. The effect of this is to neutralize the magnetic effect of the shunt coil, with the result that the armature is pulled back by the spring, thus opening the contacts and preventing any further discharge. Automatic cut-outs of this type are placed in the charging circuits of aircraft and automobiles.

**Cutting Flame.** An oxy-acetylene flame combined with an excess of oxygen. The principle of a cutting flame is based on the fact that when a spot on a piece of metal is red

hot and a jet of oxygen is turned upon the spot, the metal will burn.

**Cyaniding.** The process of impregnating the surface of an iron base alloy with carbon and nitrogen. The metal is heated in a molten bath of cyanide salts, after which it can be hardened by quenching in oil or water. The process is only used for surface hardening as its penetration is slight.

**Cyclogiro.** This is a type of aeroplane in which it is suggested that the wings should be on the side of the body in the shape of large paddle wheels (which are driven by an engine) similar to that of the paddle wheels on a ferry steamer. No cyclogiro has yet flown.

**Cyclone.** See TROPICAL REVOLVING STORM.

**Cylinder.** That portion of an engine in which the combustible mixture is compressed and ignited. The piston sliding in the cylinder is forced down by the expanding gases, thus converting the heat energy in the fuel into mechanical energy. The inlet and exhaust valves are carried in the closed end of the cylinder, i.e. the cylinder head, of an aero engine; the other end is open to the crankcase.

**Cylinder "L" Head.** A cylinder with all the valves on the same side, either side by side or one above the other. This arrangement is common in automobile engines.

**Cylinder Overhead Valve.** A cylinder with all the valves in the top of the cylinder head. This is the most common arrangement in modern aero engines.

**Cylinder "T" Head.** A cylinder with the valves on opposite sides. Not much used nowadays.

**Cylinder Multiple Head.** A monobloc head covering a number of cylinders.

## D

**Datum.** A given fact, point, or line used as a basis for calculation.

**Datum Line.** A reference line from which calculations or measurements are made.

**Day.** A unit of time on the earth. It is the time between any two successive transits of the mean sun over a given meridian.

**Dead Beat Stability.** A condition which causes a suspended or pivoted weight, when disturbed, to return directly to its original position without oscillation.

**Dead Reckoning.** The method of determining the geographical location of an aircraft without the aid of sights on heavenly bodies or landmarks, owing to bad visibility, etc. Dead reckoning is possible if the distance travelled is known, either from a log or from a knowledge of the speed of the machine and the time, together with the course followed from the point of departure. Allowance is made for drift.

**Decalage.** This is a term used to denote the setting of the top and bottom planes at different angles of incidence.

**Deceleration.** The retarding or slowing down of an aircraft or other moving body, i.e. the decrease in the rate of change of velocity, more correctly called negative acceleration. For example, if the initial velocity of the body is  $V_1$  ft. per sec., and the final velocity  $V_2$  ft. per sec., after a period of  $t$  seconds, then the deceleration

$$= \frac{V_1 - V_2}{t} \text{ ft. per sec.}^2$$

**Decimal System.** The method by which fractional parts are expressed by tenths, hundredths, thousandths, etc. E.g. 0.1 means  $\frac{1}{10}$ ; 0.01 means

$\frac{1}{100}$ , and so on. Again, 7.243 means seven units, two tenths, four hundredths, three thousandths. Micro-meters are calibrated to be read in decimals.

**Deck.** The upper shell plating of a hull or float.

**Deflating Sleeve.** A sleeve which is provided to facilitate the deflation of an aerostat's envelope or gas bag.

**Deflation.** The removal of gas or air from an aerostat, landing-wheel inner tube, etc.

**Deflection.** The bending or displacement, due to external loads, of the axis of a structural member from its normal position. The term may also be applied to the rotational movement of an instrument pointer.

**Deformation.** The amount of change in the size or shape of a body. The kind of deformation is determined by the nature of the stress from which it is caused. It may be tensile, compressive, shear, or a combination of all three stresses.

**Degree.** A degree is the 360th part of a circle. A degree is divided into 60 minutes and each minute is again divided into 60 seconds. Positions on a map or chart are expressed in degrees, minutes, and seconds. The position is defined as east or west of the meridian, and north or south of the earth's equator.

The subdivisions of thermometer scales are also called degrees.

**Degree of Latitude.** A degree of latitude is a distance of 60 nautical miles.

**Degree of Longitude.** A degree of longitude is a distance of 60 nautical miles at the equator. A degree of longitude at 30° latitude is a distance of 52 nautical miles, and a degree of longitude at 60° latitude is a distance of 30 nautical miles.

**De-icing.** Under certain atmospheric conditions ice forms on exposed portions of an aircraft during flight, and its removal is referred to as de-icing. Apart from steps taken to prevent ice formation by smearing the vulnerable parts with special substances, a common method of de-icing is to fit over the main plane and fin leading edges a rubber stocking having a number of internal pockets which may be alternately inflated and deflated. This local movement has the effect of breaking up the ice, which is then carried away by the airstream. In the case of propellers a fluid is released from the roots of the blades and is spread outwards over the blades by centrifugal force.

Carburettors are also affected by ice in the vicinity of the main jets and throttle. One type of de-icer in this case consists of an automatic device which injects alcohol from a small tank into the airstream through the carburettor. This has the effect of removing the ice. The ice-forming tendency in carburettors may be minimized by jacketing the carburettor body by the hot engine oil or cylinder coolant.

**Deka.** Prefix meaning ten in the metric system of measurement, e.g. a dekametre = 10 metres.

**Delivery Regulator.** An assembly used with high pressure oxygen. It normally consists of a pressure gauge, reducing valve, pre-heater delivery control valve, and flow meter.

**Density.** Weight per unit volume. It is expressed in pounds per cubic foot, grams per cubic centimetre, etc. E.g. density of fresh water = 62.4 lb. per cub. ft.; of aluminium = 161.7 lb. per cub. ft.

**Depression.** A condition of atmospheric low pressure.

The word depression is also used with reference to the effect obtained in a carburettor due to the flow of air through the choke.

See also TROPICAL REVOLVING STORM.

**Depth Gauge.** An instrument used in the workshop to measure accurately the depth of holes or indentations in materials.

**Derrick.** A single spar supported by stays and guys, to which a purchase is attached. (A derrick forms part of the equipment of most modern flying boats, chiefly for engine installation purposes.)

**Descent Indicator.** See RATE OF CLIMB INDICATOR.

**Destructive Tests.** Tests which destroy the specimen of material which is being tested. A test of this nature is used to estimate the ultimate strength under the various kinds of stress. In this type of test the specimen, which may be a complete fabricated structure or merely a single piece of material, is loaded until failure occurs in order to determine its ultimate strength. Tests of this nature are of particular value where built-up members, such as wing spars, complete wings, fuselages, etc., are concerned, because though it is simple enough to ensure that single members themselves are of adequate strength, by calculation, when they are assembled to form a unit many new factors, such as rigidity to withstand bending and torsional stresses as a whole, have to be taken into account. It is common practice to test to destruction, wherever possible, newly-designed structures before finally commencing production. The loading on the structure during test is arranged to simulate the actual working loads that will be carried.

**Detail Drawing.** If something has to be made which consists of a number of parts fitted together it is the practice to make drawings of each item separately. Such drawings show all the dimensions of each detail, and indeed supply the

necessary information to enable them to be made. The drawing which incorporates all the details fitted together is known as an assembly drawing.

**Detonation.** When the mixture of fuel and air is ignited in the cylinder of an engine it should, for the best results to be obtained, burn at a relatively slow rate. Under certain conditions, however, the combustion rate is so rapid as to be virtually an explosion, and this is termed "detonation." There are several theories as to what is actually happening within the combustion chamber when detonation is occurring, that most generally accepted being that when the spark passes at the plug points the mixture in the immediate vicinity is ignited, and sets up a pressure wave which drives the still unignited portion of the charge before it, thus compressing it against the cylinder head and wall. The consequence of this is to raise the pressure of the remaining unburnt gas—and, with it, the temperature—until it ignites spontaneously. When an engine is detonating or "pinking" there is a falling-off of power together with overheating. The hammer blows of the explosions place the mechanism under severe stress, causing in extreme cases damage to piston-crowns, connecting-rods, and bearings. Detonation may be controlled by using special fuels of high "octane number."

**Detonator.** A component used to detonate, or explode, a bomb, the main charge containing some substance, such as fulminate of mercury, which itself is readily detonated. A detonator may be ignited by a sharp blow, electrically, or by a fuse.

**Deviation.** If a compass needle were perfectly free and was not affected by any external influence, it would point to the magnetic

poles of the earth, i.e. it would lie in the magnetic meridian. In an aircraft where there is so much steel, e.g. engine components, gun barrels, cables, etc., the compass needle is influenced in such a manner that it is deflected slightly from the meridian. Thus the angle between the magnetic meridian and the longitudinal axis and the compass needle is called "deviation." Correction for deviation is carried out by placing small bar magnets in a special receptacle secured to the platform of the compass. The compass having been "corrected" so far as possible, the aircraft is swung round, and the compass readings on the eight chief points of the compass are noted, and a deviation card prepared which will indicate the errors when steering in various directions.

Magnetic		Steer by Compass	
N.	0	357	+ 3
N.E.	45	44	+ 1
E.	90	90	0
S.E.	135	137	- 2
S.	180	179	+ 1
S.W.	225	223	+ 2
W.	270	270	0
N.W.	315	313	+ 2

DEVIATION CARD

**Dew.** Atmospheric moisture which condenses upon objects cooler than the air.

**Dew Point.** The lowest temperature to which air at constant pressure can be cooled without condensation taking place.

**D.F.** See DIRECTION FINDER.

**D.F.C.** See DISTINGUISHED FLYING CROSS.

**D.F.M.** See DISTINGUISHED FLYING MEDAL.

**D.H.** de Havilland, the well-known firm of aircraft manufacturers.

**Diamond Plate.** So called owing

to its shape, and sometimes referred to as a tie plate. It is employed to give additional rigidity to a hull or float where one member passes through another at right angles.

**Diaphragm.** In aerostats a partition within the aerostat which is gas-tight. In instruments it is a thin, springy partition which divides certain pressure chambers.

**Die.** A mass-production tool, the purpose of which is to impress any given shape or form on metals or materials. Dies are made of hardened steel and are hollowed out to the shape it is desired to reproduce. The process is carried out in a press.

See also DIE CASTING.

**Die Casting.** A means by which molten metal is forced into suitably designed dies. Die castings are accurate castings of intricate shapes which require only a minimum of machine finishing. Die castings can be produced from most metals and alloys which are capable of being cast.

**Diesel Engine.** A name which is given to a compression-ignition power plant. The fuel used is the heavier fractions of petroleum, and as these are not so volatile as petrol the risk of fire from this type of engine is less than in the case of petrol engines. The cycle of operations—called the constant pressure cycle—occupies four strokes of the piston and is as follows: (i) induction, the piston descends and air only is admitted to the cylinder; (ii) compression, piston ascends and compresses the air to a pressure of about 500 lb. per sq. in. and a temperature of approximately 1000° F.; (iii) working stroke, during the first portion of which oil is sprayed into the cylinder either by high pressure air-blast or by a pump. On meeting the high temperature air in the cylinder the fuel ignites and burns relatively slowly, driving

the piston downward. When all the fuel is burnt the expanding gases force the piston to the end of the stroke; (iv) exhaust, piston ascends and burnt gases are expelled from the cylinder.

In order to produce a sufficiently high temperature to ignite the charge, high compression ratios are a necessity, 14:1 being an average value, consequently relatively high thermal efficiencies are obtained. Owing to the high maximum pressures attainable within the cylinder Diesel engines have to be made very robust, and consequently the power/weight ratio is lower than that of a petrol engine of similar power.

**Differential Ailerons.** Ailerons so interconnected that a movement of the controls results in the upward displacement of one aileron being greater than the downward displacement of the other. The object of this differential movement of the ailerons is to increase the drag and decrease the lift on the wing with the upgoing aileron, thus assisting the aircraft to turn.

**Diffuser.** The diffuser or shrouded jet is a component of certain types of carburettor. It consists of four brass tubes mounted concentrically in a base plug which contains the main jets. The inner tube supplies the mixture for starting-up and slow running. Round this is the diffuser tube which carries a solid brass head in which are a number of holes drilled radially and communicating with the interior. The wall of the diffuser tube contains a number of holes. Outside the diffuser is the guard tube fixed to the base plug at its lower end of such a length that there is a space between it and the under side of the emulsion head. Finally, the outer air tube fits snugly between the head and the base. This tube has a ring of holes near its bottom end.

When the engine is running light the fuel from the main jet fills the inner three tubes to a level determined by the setting of the float mechanism. As the throttle is opened and more fuel passes to the engine, the fuel level in the tubes drops and air entering the ring of holes in the outer tube passes over the top of the guard tube, and, entering through the holes in the diffuser, mixes with the fuel, forming an emulsion which in turn is delivered to the main airstream through the emulsion holes. This arrangement allows the fuel to be thoroughly pulverized and mixed with the air, thus ensuring efficient combustion.

The term diffuser is also used to describe the ring of fixed blades placed round the periphery of a supercharger impeller, the object of which is to change the velocity energy of the air/fuel mixture into pressure energy.

**Dihedral Angle.** Geometrically, the angle between two planes. In the case of aeroplanes the dihedral angle is the angle between each plane and the lateral axis of the machine. When the planes are tilted upwards towards the wing tips the dihedral is said to be positive, when downwards, negative. The reason for using a dihedral angle is to improve the lateral stability of the aircraft.

**Dimension Limits.** Within the limitations of normal production engineering it is not possible to make components, or to drill holes, exactly to their nominal dimensions. Recognizing this, certain inaccuracies are accepted by manufacturers, and to this end systems of acceptable limits have been worked out, notably by the British Standards Institution, where maximum deviations from the nominal dimensions are laid down for various types of fits and classes of work. On draw-

ings it is usual to show the nominal dimension and the limits thus: 4.250 in.  $\pm$  0.001, meaning in this case that one-thousandth of an inch over or under the nominal size of 4.250 in. would be acceptable.

**Dip.** The vertical angle between a horizontal plane and the longitudinal axis of a magnetic needle. Dip is due to the earth's magnetism, which not only causes the needle to lie in the magnetic meridian, but also exerts a downward force on it as well. In the northern hemisphere the north pole of the compass needle will tilt downwards, more as it approaches the pole and less the farther it is from it. At the Equator the needle is horizontal, and in the southern hemisphere it is the south pole which dips downwards.

**Direct Current.** A flow of electrons in one direction under the influence of unchanging e.m.f. as obtained from a dynamo, etc.

**Direct Drive Engine.** An engine in which the propeller is driven direct from the crankshaft without a reduction gear.

**Direct Drive Supercharger.** A type of supercharger in which the impeller is driven directly by the engine through suitable gearing in contradistinction to an impeller which is driven by an external agency such as an "exhaust turbine," etc.

**Direction Finder.** A radio receiving aerial which indicates the bearing of the transmitting station. It is usually of the loop type.

See also RADAR.

**Directional Gyro.** See TURN INDICATOR.

**Directional Stability.** An aeroplane is said to be directionally stable if, after being temporarily forced off its course, its tendency is to return immediately to its original course without the use of controls. The area of the fin has a considerable influence.



**Dirigible.** A colloquial term used to indicate an airship. This use as a noun is, strictly speaking, incorrect as the term is an adjective meaning steerable.

**Disc Area.** The area described by the tips of the rotating blades of a propeller.

**Dischargeable Weight.** All loads and equipment which may be jettisoned in an emergency from an aircraft without interfering with its control in the air.

**Discontinuity.** A term used in meteorology to denote a sharp variation at a known point which occurs in a short time or a short distance. It may apply to pressure, temperature, humidity, and wind.

**Dissolved Acetylene.** Acetylene gas which is stored in steel bottles by dissolving it in acetone under pressure. Acetone can absorb 25 times its own volume of acetylene at 60° F. at atmospheric pressure.

**Distillate.** See FUEL OIL.

**Distillation Test.** This is a standard laboratory test designed to gauge the volatility of liquid fuels, particularly petrol. The apparatus consists of an Engler flask, a thermometer, a simple condenser, and a graduated cylindrical receiver, together with the requisite supports and a heater. 100 c.c. of fuel is measured into the receiver and then poured into the flask, which is closed by a cork through which passes the thermometer. Gentle heat is applied under the flask and the temperature noted at which the first drop of distillate falls into the receiver. This temperature is known as the initial boiling point of the petrol. The process is continued, the source of heat being adjusted so that the rate of distillation is about two drops per second, and the percentage of distillate noted every 5° C. or 10° C. rise in temperature until the flask is empty. The temperature at which the flask

becomes dry is known as the "end point." The initial boiling point, end point, and percentage distilled at certain given temperatures are laid down for aero-engine fuels in Air Ministry specifications.

**Distinguished Flying Cross.** This is a decoration granted to officers and warrant officers for exceptional valour, courage or devotion to duty whilst flying in active operations against the enemy. It was instituted by Royal Warrant, dated 3rd June, 1918. The colours of the ribbon are violet and white in alternate diagonal stripes  $\frac{1}{2}$  in. in width.

**Distinguished Flying Medal.** This is a decoration granted to non-commissioned officers and airmen for exceptional valour, courage or devotion to duty whilst flying in active operations against the enemy. It was instituted by Royal Warrant, dated 3rd June, 1918. The colours of the ribbon are violet and white in alternate diagonal stripes  $\frac{1}{4}$  in. in width.

**Distress Signals.** S.O.S. in Morse code. MAYDAY in the spoken word. N.C. in the international code by flags.

**Disturbance.** In meteorology this term is generally used in connexion with a depression or tropical revolving storm. It is a local departure from the normal wind conditions in any part of the world.

**Disturbing Moment.** A moment about one of the axes of an aircraft due to some external force such as an air gust, enemy action, etc., which tends to upset the conditions of equilibrium during flight. It may be corrected automatically by the inherent stability of the machine or by the pilot using his controls.

**Dive.** A steep descent of an aeroplane with or without engine power. The air speed is generally greater than the maximum speed in horizontal flight.

**Dive Bomber.** A bomber specially designed to dive toward the objective, perhaps for many thousands of feet. The bombs are released as the machine is pulled out of the dive. To prevent the speed becoming excessive after a prolonged dive, devices which act as air brakes are fitted.

**Dive Bombing.** The method in which bombing is effected with dive bombers. The aeroplane dives between 60° and 90° at the target at maximum air speed. The bombs are released just before the pull-out.

**Divergence.** In aeronautics this is a disturbance which increases without oscillation.

In meteorology when more air flows out of a given area than flows into it, there is said to be a divergence. The deficiency of air must be made good by a downward current from the upper layers of the atmosphere.

See also **SUBSIDENCE**.

**"D" Licence (Ground Engineers).**

A licence issued to persons competent to undertake the inspection of aircraft after overhaul.

Licences are valid for one year at a fee of 21s., and may be renewed at a fee of 5s. on evidence of recent practical experience in the duties covered by the licence.

**Dock.** This may be of the fixed or floating type, and is used for the housing and repair of large seaplanes.

**Doldrums.** A belt of low pressure extending around the earth at the Equator. The belt moves northward in summer and southward in the winter. The Doldrums are often associated with heavy rains and thunderstorms, but normally are regions of calms and variable winds.

**Doping.** The treatment of the fabric covering of an airframe with acetone dope or similar substance with the object of tautening and rendering it watertight. The enve-

lopes of aerostats are doped to render them airtight.

**Dorsal.** A technical term used in hull construction. It denotes the member which runs fore and aft on the top centre line of the hull and connects the top of the stem and the stern post.

It is also used to denote gun-turrets situated on the top of the fuselage of aircraft, e.g. dorsal turret.

**Dorsal Stringer.** The top main longitudinal member of a hull or float which is built on the longitudinal system.

**Dote.** A term which denotes a disease in wood.

**Double-row Radial Engine.** An engine which has two rows of cylinders arranged radially around a common crankshaft. The front and rear cylinders in many cases are not in line with one another, but staggered for cooling purposes.

**Doubling Plate.** A plate or plates fitted internally or externally on shell plating or similar surface of a hull or float at points where local stresses occur, giving additional stiffness and distributing stresses over a larger area.

**Down-draught.** A current of air in a downward direction flowing over an obstacle, or cool air descending. Colloquially known in meteorology as an air pocket.

**Down-draught Carburettor.** A type of carburettor in which the air is taken in at the top. It travels downwards through the chokes to the jets. The advantages claimed for this type are (a) the reduced risk of fire, and (b) that with the more direct air passage there is an improved distribution of the fuel/air mixture to the combustion chambers.

**Downwash.** When the air flows over the surface of an aerofoil it is travelling downwards after leaving the trailing edge. This is called

**downwash.** Account has to be taken of this in aeroplane design because downwash affects the direction of the air which strikes the tail plane, particularly in biplanes.

**Downwash Angle.** The angle through which the airflow is deflected by an aerofoil. It is measured in a plane parallel to the plane of symmetry.

**Draft.** The vertical distance from the load waterline on a flying-boat hull to the lowest point of the keel.

**Drag.** If air flows past an aerofoil which is inclined to the direction of the airflow it can be shown that on the upper surface of the aerofoil the pressure of the air is reduced whilst underneath it is increased. This produces a resultant force which tends to force the aerofoil, both upwards and backwards. Resolving this resultant force into two components, (i) in a direction parallel to the airflow, and (ii) in a direction normal to the airflow, the former is called "drag" and the latter "lift."

**Drag Axis.** A straight line parallel to the direction of the relative airflow and passing through the centre of gravity.

**Drag Rope.** A rope which is thrown overboard from a balloon. It acts as a brake and also as variable ballast when making a landing.

**Drag Strut.** An internal bracing system used in the early designs of aircraft wings. It is a fore and aft compression member.

**Drag Wire.** A wire which resists the tendency of a wing to fold backward. Drag wires run outward and backward from the fuselage towards the wing tip, and are sometimes called "drift wires." Modern monoplanes do not require drag wires.

A wire of this type is used in aerostats to transmit the drag from the car to the envelope.

**Drain Plugs.** Fittings to allow

the various compartments of hull, sump, etc., to be drained of water or other liquid. They are fitted to the lowest point of each compartment.

**Draining Pump System.** This consists on certain floats of a tube fitted internally and reaching from the planing bottom to the top cover. It is an adaptor to which a hand pump may be attached. This eliminates the necessity of beaching for draining purposes.

**Draughtsman.** A person who makes drawings or graphical representation of parts of objects by the use of drawing instruments.

**Draw Bench.** A metal bench which includes a mechanism to cold-draw strip metal through suitable dies, so as to give the metal the required shape or section.

**Drawing Die.** A die used in a power press for deep forming operations, i.e. for producing deep bowl-like shapes.

**Drawing (Metals).** To force metal to take definite shapes by the use of forming punches and dies. The word drawing is used because the process generally consists of drawing the metal through the die in a uniform manner so that there will be no fractures. The process is frequently carried out with the metal in the cold state, hence, for example, "cold-drawn" tubes, wire, etc.

**Drift.** The lateral movement of an aircraft in a horizontal plane due to side winds. Drift is designated as "right" or "left," depending upon the side of the desired line of flight to which the machine moves.

**Drift Angle.** The horizontal angle between the longitudinal axis of an aircraft and its track relative to the ground. The angle of drift may be determined by an instrument called the drift indicator.

**Drift Angle Sight.** An instrument

which is used for determining the drift angle of an aircraft. Generally known as a drift indicator.

**Drift Bar.** That part of a drift indicator which indicates the apparent direction of motion of the aircraft in relation to the ground. It consists of a wire which is set along the direction of motion.

**Drift Indicator.** An instrument which is used to measure the angle of drift. This is done by adjusting the sight wire until the selected ground object appears to travel parallel with it. A system of calibration on the drift indicator enables the angle of drift to be read direct.

**Drill Bushes.** Hardened steel guides which are inserted in jigs for the purpose of providing a guide for the drills used in precision work.

**Drill Jig.** A mechanical device which holds parts of a structure in the correct position for drilling holes. The design of the jig is such that the holes are all correctly positioned within fine limits of accuracy. Jigs of this nature are an important aid to the mass production of interchangeable engineering components.

**Drill Template.** A type of template which has hardened steel bushes for the purpose of guiding the drill and thus ensuring the exact spacing of the holes in the fabricated part.

**Driving Fit.** Refers to a particular mating fit between a male component such as a shaft, bush, etc., and the hole in which it is to be assembled. In the case of a driving fit the shaft has to be forced into the hole, and to ensure this it is finished to a diameter slightly in excess of the diameter of the hole in which it is to be mated.

**Drizzle.** Precipitation in the form of small water droplets, originating in fog or stratus clouds.

**Drogue.** A type of trailing sea anchor. The term is also applied

colloquially to a fabric target towed by aircraft and used in connexion with air gunnery practice.

**Drooped Ailerons.** Ailerons adjusted so as to "droop," i.e. both ailerons down  $10^{\circ}$  to  $15^{\circ}$  with the controls centralized.

**Dropping Angle.** In air bombing this is the angle between the vertical and a straight line joining the target and the aircraft at the moment of the release of the bomb.

**Drought.** A long period of dry weather.

**Dry Adiabatic Lapse Rate.** The lapse or rate of decrease of temperature with height of dry air near the earth's surface, approximately equal to  $1^{\circ}$  C. per 100 metres or  $5.5^{\circ}$  F. per 1000 ft.

**Dry Battery.** A number of dry cells in series and provided with tapping sockets giving different voltages.

**Dry Cell.** See BATTERY, DRY.

**Dry Sump.** A dry sump engine is an internal combustion engine in which the oil is not allowed to remain in the lower portion of the crankcase; it is pumped out and passed to a tank external to the engine. The purpose of a dry sump is to prevent the oil being thrown around the engine during violent manoeuvres. It also lessens fire hazard, and, in addition, better cooling of the oil is obtained.

**Dry Weight of an Engine.** See GROSS DRY WEIGHT; NET DRY WEIGHT.

**D.T.D.** These initials are frequently found prefixing the identification number of a British Air Ministry specification, e.g. D.T.D. 109, etc. They stand for "Directorate of Technical Development."

**Dual Control.** This denotes that the controls on an aeroplane are duplicated. It is normally used for training purposes, but may also be used in large aeroplanes where two pilots are carried.

**Dual Purpose Generator.** A type of generator which can supply high and low tension current for the anodes and filament of radio valves.

**Ductility.** This is the term used to describe that property in certain metals which enables them to withstand a large amount of deformation without fracture. Ductile metals such as iron, steel, copper, etc., can be drawn out by tension to a considerable extent, e.g. as in wire drawing.

**Dust Counter.** An instrument used by meteorologists which records the number of dust particles in a predetermined volume of air.

**Dust Devil.** Small whirlwinds over desert regions which are formed by strong convection currents raising sand in a vertical column.

**Dust Storm.** See DUST DEVIL; SAND STORM.

**Duralumin.** An aluminium alloy having the following approximate composition: copper 4 per cent, magnesium 0.6 per cent, iron 0.30 per cent, the remainder aluminium. Sometimes small percentages of manganese and silicon are also added. Duralumin is manufactured in the form of sheet, tube, bar, forgings, etc., and is extensively used in the aircraft industry. In the wrought form its tensile strength compares favourably with that of mild steel, whilst it is only about one-third as heavy. It may be softened or annealed by heating to a temperature of 380° C. and cooling in air. After annealing, in order to bring the metal back to its condition of maximum strength, a final heat-treatment operation (normalizing) is necessary, consisting of heating to a temperature of 495° C. and quenching in water. The metal is then allowed to "age harden" at room temperature for a period of four days. Duralumin must never be heated above 505° C., otherwise its internal structure is damaged,

hence very careful temperature control must be exercised during heat-treatment. For this reason this alloy is generally heated in a salt bath.

**Dynamic Balance.** This refers to the condition of balance of a rotating body. When a body is mounted on knife edges about its axis of rotation and will remain at rest whatever its rotational position, it is said to be in "static balance." If, however, the body contains a number of weights rotating about a common axis but in several planes, e.g. a crankshaft, it may be in static balance, but when it is rotated at a uniform speed it will be out of balance and vibration will result. For a body to be in dynamic balance the sum of the moments of the centrifugal forces due to the rotating weights, about any reference plane, must equal zero.

**Dynamic Load.** Any load placed on an aircraft when manoeuvring due to acceleration. Under conditions of straight, level flight the lift is equal to the weight of the aeroplane. This is called unit load or, since the force on the aircraft is equal to the mass of the machine multiplied by the acceleration due to gravity, it is referred to as a force of "one *g*" ( $g = 32.2$  ft. per sec.<sup>2</sup>). The ratio of the load, or lift, during any manoeuvre to the unit load is called the load factor. As the mass of the aircraft is constant, during any evolution it may be stressed to  $3g$ ,  $4g$ , etc.

See also DYNAMIC BALANCE.

**Dynamo.** An electric machine which provides direct current by virtue of a magnetic field.

**Dynamometer.** A dynamometer is an apparatus used in the measurement of the power output from a prime mover. The dynamometer, or brake, is directly coupled to the engine shaft and provides the load against which it operates, at the

same time indicating certain data from which the brake horse-power can be computed. There are two classes of brake, viz., the absorption type and the transmission type. In the former all of the power output is dissipated in the dynamometer either by churning water or air or by friction, whilst in the latter type the output is measured without material loss by means of a torsion-meter or by driving an electric generator.

For the measurement of high powers such as from an engine, the most commonly used absorption type is the Heenan and Froude Hydraulic Dynamometer, though for running-up tests after overhaul

the calibrated propeller or fan is frequently used. For flight tests, use is made of the torsion-meter which enables the shaft torque to be measured from which the horse-power can be calculated. If an electric generator is used the shaft horse-power of the engine can be found by noting the electrical output from the generator and making due allowance for the latter's efficiency.

**Dyne.** In C.G.S. units, the dyne is the unit of force and may be defined as that force which will give a mass of 1 gram an acceleration of 1 cm. per sec. per sec. A force equal to the weight of one gram is the equivalent of 981 dynes.

## E

**Earth-inductor Compass.** A compass in which the needle movements depend on the current generated in a coil revolving in the earth's magnetic field. The earth, being a magnet, possesses a magnetic field between the magnetic north and south poles. If a conductor is rotated in the field it will have an e.m.f. induced into it, the magnitude of which will depend upon the rate at which it cuts the lines of force. If the conductor is at right angles to the earth's magnetic meridian, it will be cutting the lines at a maximum rate, whilst if it lies in the meridian the rate of cutting will be zero. By incorporating such a conductor in an electric circuit a current will flow which can be made to operate a suitably calibrated recording instrument.

**Economic Speed.** The speed at which the fuel consumption per unit of distance covered is a minimum. In modern aircraft this is accomplished by slightly weakening the fuel/air ratio, reducing the boost pressure, and adjusting the blade angles of the variable pitch propellers.

**Eddies.** When a fluid is flowing over a non-streamlined body the flow ceases to be smooth or streamlined and becomes turbulent and "swirling." The breakdown of the laminar flow into eddies in the case of an aerofoil causes loss of lift and increased drag.

When a liquid is flowing through a pipe eddies will be formed at any sudden change in the cross-section of the pipe, at valves or obstructions, resulting in increased resistance or, more technically, "loss of head."

**Eddy Resistance.** The portion of the total resistance which is due to

the viscous fluid flowing past a solid object and forming eddies. This stops the smooth streamline flow.

**Effective Pitch.** The distance an aircraft moves forward in still air for one revolution of the propeller.

**Efficiency.** Efficiency is a term in constant use by engineers and expresses the ratio, generally as a percentage, of the "actual" functioning of some component or mechanism and the "ideal" functioning when there would be no losses. As an illustration, consider the case of a simple lifting machine such as a screw-jack, whose velocity ratio is 150. If there were no losses due to friction, etc., a force of 10 lb. should lift a weight of 1500 lb. Actually the load lifted may only be 600 lb., hence the mechanical efficiency of the jack under these conditions would be

$$\frac{600 \times 100}{1500} = 40 \text{ per cent.}$$

See also MECHANICAL EFFICIENCY; THERMAL EFFICIENCY; VOLUMETRIC EFFICIENCY.

**Elastic Limit.** The maximum stress that can be applied to a material without causing a permanent set, i.e. the maximum stress at which the test specimen will return to its original dimensions when the applied load is removed.

**Elasticity.** This is the property possessed by a material which allows it to change its dimensions, e.g. stretch, shorten, etc., under the action of a force, then to return to its original condition when the force is removed.

See also HOOKE'S LAW.

**Electric Inertia Starter.** See INERTIA STARTER.

**Electric Resistance Spot Welding.** Welding by passing electrical energy

through the metals and simultaneously applying a compressive load by forcing the electrodes against the metals being joined.

**Electric Starter.** An engine starter which utilizes an electric motor to rotate the crankshaft.

**Electrical Discharge Gear.** Electrical conductors, usually of copper, which are mounted on fabric bands round a captive balloon. They are fitted for the purpose of earthing the envelope.

**Electrical Resistance.** The resistance of a conductor to the flow of electricity. Materials such as silver, copper, platinum, etc., which offer little resistance to the flow of electric current, are called conductors, whilst those such as porcelain, glass, rubber, etc., where resistance is extremely high, are termed insulators. For conductors of the same material the resistance is directly proportional to their length, and inversely proportional to the area of their cross-section. In the case of most metals, with the notable exception of platinum, the resistance increases with rise in temperature. The electrical unit of resistance is the ohm, which may be defined as the resistance offered to a steady electric current by a column of mercury at 0° C., 14.5421 grams in mass, of constant cross-sectional area and 106.3 cm. long. This is the definition of the International Ohm.

**Electrically Heated Clothing.** Specially constructed clothing for aircrews in which electrical wires are incorporated in the manufacture so that at high altitude, when the temperature is low, they can be switched on in order that the wearer can be kept reasonably warm.

**Electrode.** A conductor which is at a terminal position in an electrical circuit, e.g. anode and cathode in electrolysis; the "points" in a sparking plug; the carbons in an arc lamp, etc.

**Electrolytic Corrosion.** When two different metals are joined together, or even where there is a junction of similar metals which have been heat-treated to a different degree, corrosion will occur at the joint due to galvanic action. To prevent this in aircraft construction the parts are given a protective covering.

**Electromagnetic Induction.** In 1831, Faraday discovered that if a conductor cuts through a magnetic field, the conductor will have an electromotive force (e.m.f.) induced in it. The magnitude of the e.m.f. depends upon the rate of cutting the lines of force—the greater the rate the higher the induced e.m.f., and vice versa. The magnetic field may be that across the poles of a permanent magnet or that in the vicinity of a current-bearing conductor. The discovery of the laws of electromagnetic induction paved the way for the development of the electric generator, magneto, transformer, etc.

**Electromagnetism.** The magnetic field produced around a conductor when a current is flowing through the conductor. Thus a current flowing through a single wire produces a field which is circular and concentric with the conductor. The stronger the current the stronger the magnetic field. Similarly if a number of coils be wound on a former a magnetic field will be produced which will be of similar form to that associated with a bar magnet. In this case the field intensity depends on the strength of the current and the number of coils, i.e. "ampere-turns." In a single wire, if the direction of the current is away from the observer the direction of the field will be clockwise, and if the current flows in the conductor towards the observer, the field will be counter-clockwise.



In the case of the coil, if looked on at one end, when the direction of the current is counter-clockwise, the polarity of the end nearer to the observer will be north. If the direction of the current is reversed the polarity of the ends will also be reversed.

**Electronics.** This is the application of wireless principles to mechanical movement.

In the gyro fluxgate compass, for example, the earth's magnetic field is used to develop minute electrical

the chord of the aerofoil to which it is hinged.

**Elevator Lever.** The arm which connects the actuating mechanism to the elevator.

**Elongation Test.** This is normally a part of a tensile test where a specimen of material is placed in a tensile testing machine and gradually loaded until fracture occurs. When the specimen has been broken the ends are brought together again so that the final length can be measured. Then

$$\begin{aligned} \text{Percentage elongation} &= \frac{(\text{Final length} - \text{Gauge length}) \times 100}{\text{Gauge length}} \\ &= \frac{\text{Total stretch} \times 100}{\text{Gauge length}} \text{ per cent} \end{aligned}$$

impulses which, when amplified, turn a needle. Such a compass does not go off its reading when an aeroplane turns, climbs, or makes a sharp dive. It does not oscillate in rough weather, and requires no correction card because it gives a fully corrected reading at all times.

**Electrostatic Field.** An electric field (stationary) around a charged conductor.

**Elektron.** A magnesium alloy. It is very light and is composed of approximately 95 per cent magnesium, 4.5 per cent zinc, and 0.5 per cent copper. It is not very strong, but since it can readily be cast it is used chiefly for unstressed parts.

**Elevator.** A movable aerofoil hinged behind the tail plane, the function of which is to provide longitudinal control. When the control column is moved forward the elevators are depressed, thus increasing the lift on the tail and causing the nose of the aircraft to drop. Conversely, when the control column is pulled back the elevators are raised and the nose rises.

**Elevator Angle.** The angle between the chord of the elevator and

The percentage elongation is regarded as a measure of the ductility of the metal.

**Emergency Landing Area.** A specially selected open stretch, which may be either water or land, adapted for the alighting and taking off of aircraft, but which is not equipped with facilities for shelter or repair of aircraft.

**Empennage.** A name for the entire tail group of an aeroplane, consisting of the tail plane, rudder, fin, and elevator. This term is not now in general use.

**Empirical Formula.** A formula which has been discovered or built up from working experience, shop practice, etc., rather than from mathematical theory.

**Endurance.** The maximum period of time that an aircraft can remain in the air at a given speed and altitude without refuelling.

The term is also used in connexion with fatigue in metals, when it refers to the number of applications of a given maximum stress the material can withstand without fracture.

**Energy.** The ability of a body to do work on account of its position, condition, velocity, chemical com-

position, high temperature or electrical pressure. Energy cannot be created or destroyed but can be changed from one form to another.

Thus a weight of 100 lb. placed at a height of 10 ft. from the ground possesses 1000 ft.-lb. of position or "potential" energy which it can give out in working, say, a clock mechanism. Again, the chemical energy in the fuel is translated into mechanical energy in an engine which by driving a vehicle or aeroplane can be changed again into movement energy (kinetic energy).

**Engine Controls.** The mechanisms by which the revolutions per minute and the power output of an engine are controlled by the pilot. The throttle control system consists essentially of a lever in the cockpit which by means of a linkage opens or closes the throttle in the carburettor. Interposed between the pilot's throttle lever and the throttle itself is a connexion to the automatic boost control which automatically operates the throttle to produce a predetermined boost pressure in accordance with the setting of the pilot's control.

**Engine Cowling.** A metal covering fixed round all or part of an aeroplane engine which can be removed to inspect or repair the engine.

**Engine Log Book.** A specially prepared book for each engine in which all details of the engine's history are carefully recorded. Entries consist of current reports of periodic inspections, duration of running times both on the ground and in the air, and also details of any damage sustained, overhauls, and modifications.

**Engine Lubricating Oils.** Lubricating oils used in modern aero engines are usually mineral oils produced by a process of distillation and refining from crude petroleum.

The best oils contain a high proportion of hydrocarbon fractions of the paraffin series ( $C_nH_{2n+2}$ ). The desirable qualities in a lubricating oil for internal combustion engines are that it should (i) be chemically stable, i.e. not prone to carbonization, oxidation or gumming; (ii) be free from acid; (iii) have a high flash point; and (iv) have not too high a viscosity at ordinary atmospheric temperature, to facilitate starting (but it should not become too thin at operating temperatures to prevent its being squeezed out of bearings, etc.).

The earlier types of rotary aero engines used vegetable oil, chiefly castor oil, as a lubricant, because in that type of engine the petrol was sprayed into the crankcase, but this did not dilute or interfere with the lubricating qualities of the castor oil. Vegetable and animal oils are very good lubricants, but they tend to oxidize and gum-up. They also contain acid which attacks, by corrosion, ball bearings, etc. For automobile engines blended oils containing mineral and vegetable oils have been extensively used and have proved efficient lubricants.

The function of the lubricant in an engine is to reduce friction between the working parts as well as to carry away heat generated thereat.

**Engine Speed Indicator.** This is sometimes referred to as a revolution indicator or tachometer, and is used to indicate the rate of revolutions, i.e. r.p.m. of the crankshaft of the engine. An engine speed indicator is a different instrument from a revolution counter, the latter being used in conjunction with a watch for counting the number of revolutions in a given time.

A mechanical speed indicator consists of a spindle driven through a reduction gear from the engine,

which carries a cross link pivoted at its centre and weighted at its outer ends. The pivoted cross link is held at an acute angle to the axis of the driving spindle by a spring. As the speed of the main spindle increases, the cross link, under the action of centrifugal force, tends to assume a position at right angles to the driving spindle. This movement, controlled by the spring, is transmitted to a sleeve sliding on the spindle and in turn by quadrant and pinion mechanism to the pointer moving over a dial. The dial of the instrument is calibrated in revolutions per minute (r.p.m.).

See also REVOLUTION INDICATOR.

**Engine Speed Recorder.** See REVOLUTION INDICATOR.

**Engine Speeds.** See MAXIMUM PERMISSIBLE REVOLUTIONS PER MINUTE; NORMAL REVOLUTIONS PER MINUTE.

**Engine Valves.** The inlet and exhaust valves used in an internal combustion engine through which the gases enter and leave the cylinders respectively. They are of the mushroom type, having circular heads, on the underside of which is formed the "seat." Integral with the head is the valve stem. Owing to the severe conditions under which they operate, particularly the exhaust valves, aero-engine valves are made of special alloy steels. As a further protection against burning and wear it is common practice to apply a surface treatment of a very hard, corrosion-resisting alloy steel to the exhaust valve seat and crown. To assist in cooling the exhaust valve it is usual to make the valve stem hollow and to place sodium therein, the open end being finally closed by a steel plug. The sodium being a good conductor of heat conducts the heat from the head down the stem, when it is dissipated through the valve guides to the cylinder block.

See also SLEEVE VALVES.

**Engine Weight in Running Order.**

The gross dry weight of an engine including the radiator, water, inter-connecting pipes, and controls. The internal parts must be in the ordinary oily condition. This weight excludes fuel, oil, reserve water, tanks, exhaust pipes, and engine instruments.

**Engine Weight per Brake Horsepower.** The total dry weight of an engine divided by the rated brake horsepower.

**Ensign.** See CIVIL AIR ENSIGN; ROYAL AIR FORCE ENSIGN.

**Envelope.** The outer covering of an aerostat, usually made of fabric. It is doped to make it waterproof, and its function is to provide the final streamlined form of the structure.

**Equator.** An imaginary line upon the surface of the earth which it divides into equal parts called the northern hemisphere and the southern hemisphere. The Equator is the datum from which latitude is measured.

**Equilibrium Height.** The height under known conditions at which equilibrium is established between lift and weight of a free balloon.

See also ARCHIMEDES' PRINCIPLE.

**Equilibrium Value.** The variation in change point temperatures on cooling and heating a steel.

**Equinox.** This refers to the times when the sun enters the two equinoctial points, the vernal equinox and the autumnal equinox. All places at these times experience a day and night each of 12 hours' duration.

**Erg.** A measurement of work or energy. It is the work done by a force of one dyne acting through a distance of one centimetre, and is a small unit of measurement in the metric system.

**Eta Patch.** The fan-shaped patch made of fabric and webbing that is secured to the envelope of an

aerostat. The mooring guy is attached to the eta patch.

**Etching.** This refers to the application of an acid solution to finished steel parts after immersion in caustic soda to remove grease, etc., in order to show up any cracks or surface defects. The deposit formed is removed with acetone and the part dried; afterwards the acid will ooze from any cracks that may be present.

This term is also used to describe the final process in the preparation of iron and steel specimens to be used for microscopical examination. As metals are opaque it is only possible to look at their structure on a specially prepared surface of the specimen to be examined.

**Ethyl Alcohol.** A compound of hydrogen, carbon, and oxygen, obtained from certain organic compounds. It is possible to use ethyl alcohol as an internal combustion engine fuel, and a high compression ratio (which means increased engine efficiency) can be used owing to its anti-detonating qualities. It has a great affinity for water and has a low heat value.

**Ethylene Glycol.** A chemical substance consisting of carbon, hydrogen, and oxygen, which forms  $C_2H_6O_2$ . It is used as a coolant in liquid-cooled engines. It is colourless, non-corrosive, non-inflammable, non-poisonous, and almost odourless.

It has a high boiling point and a low freezing point. Owing to its high boiling point in relation to water a smaller radiator can be used.

**Eutectic.** This is used to indicate the mixture or alloy possessing the lowest freezing point which can be prepared out of two metals being used. It corresponds with a definite proportion of the metals, has a fixed freezing point, and forms a finely divided aggregate of the two constituents.

**Eutectoid.** This is similar to a eutectic, the difference being that it forms out of a solid solution instead of a liquid.

**Evaporation.** That process by which a liquid becomes a gas by applying heat.

**Evaporative Cooling.** A system of cooling used in internal combustion engines which takes advantage of the latent heat of evaporation. The cooling fluid is allowed to boil, after which it is condensed and returned to the cylinder jackets.

**Evaporimeter.** An instrument which measures the rate of evaporation of water into the atmosphere.

**Exhaust Branch Pipe.** A short pipe which transfers the exhaust gases from the cylinder of the internal combustion engine to the exhaust manifold.

**Exhaust Driven Supercharger.** A supercharger which is driven by the exhaust gases of the engine through the medium of a turbine.

**Exhaust Flame Damper.** A device which prevents exhaust gases from an internal combustion engine passing into the atmosphere whilst still burning.

**Exhaust Gas Analyser.** An instrument designed to indicate the correct fuel/air ratio of an internal combustion engine by analysing the exhaust gases.

Gas analysers are of two types—  
(a) a type which depends upon the absorption of carbon dioxide by a substance such as caustic soda;  
(b) a type which depends upon the electric unit employing a known resistance and the thermal conductivity of the exhaust gases. In the exhaust gases of an internal combustion engine may be the following: carbon monoxide, carbon dioxide, nitrogen, oxygen, and hydrogen.

**Exhaust Manifold.** An exhaust system of an internal combustion engine in which short stacks lead

into a common pipe or collector ring.

**Exhaust Ring.** A circular manifold fitted to an internal combustion engine for the collection of the exhaust gases.

**Exhaust System.** The engine parts and accessories of an internal combustion engine, for conducting the exhaust gases from the combustion chamber into the atmosphere.

**Exhibition Parachutists' Licences.** To be eligible for an Exhibition Parachutist's Licence the applicant must have made at least ten trial descents. For this purpose a temporary permit is issued. The applicant must also hold a Ground Engineer's Licence in Category "X" (Parachutes). These licences are valid for a stated period not exceeding twelve months.

**Experimental Mean Pitch.** The distance through which a propeller would advance along its axis during one revolution assuming that it was giving no thrust.

**Exploder.** A term sometimes used to indicate a part of a bomb which contains a substance for detonating the main charge.

**Extensometer.** An instrument for measuring longitudinal changes in

the length of a test specimen. Small changes of one ten-thousandth of an inch can be measured. The stress in the test specimen is recorded during the test.

**External Supercharger.** A supercharger of the type in which the impeller is located in the induction system on the inlet side of the carburettor.

**Extruded Sections.** The forming or shaping of a material by forcing it through a die or number of dies. In the construction of aircraft extruded aluminium alloy shapes are used very extensively.

**Extrusion.** The process by means of which metals are shaped into defined cross-sectional shapes by being forced through steel dies of the appropriate shape.

Heat is sometimes applied to soften the material being extruded. On completion the part has a smooth, hard surface, and generally it is free from flaws. The machine employed generally consists of a hydraulic system which forces the material through the hardened steel dies.

**Eye of Storm.** The central area of a tropical cyclone. This area is calm.

## F

**F.** Letter used to denote fighter aircraft. The letter is used as a prefix to the mark number of the aeroplane and denotes its duty; for example, Mosquito F II.

**F.A.A.** See FLEET AIR ARM.

**Fabric.** The name given to the material sometimes used to cover certain aircraft surfaces. It is woven from yarns of either unbleached Irish linen or cotton. The former is strong, durable, and light, and is used for general coverings, e.g. control surfaces, wings, etc., whilst the latter is lighter in weight and is used for covering plywood.

The yarns running lengthwise through the fabric are called "warp," and those running crosswise "weft." The selvage is the non-fraying edge.

**Factor of Safety.** A factor of safety is a number by which the ultimate or "breaking" stress of a material is divided to obtain the safe working stress, or, conversely, it is the ratio of the ultimate stress to the safe stress. The choice of a suitable factor, which may vary from two to eight or more, depends upon a number of things, e.g. the degree of accuracy with which the maximum loads on the structure can be determined, consequences of failure, liability to deterioration in use, etc.

**Fahrenheit Scale.** The thermometer scale on which ice melts at 32° above zero, and water boils at 212°.

**F.A.I.** See FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE.

**Fairing.** A streamlined metal, wood or fabric covering whose main function is to reduce the head resistance or drag of the part to which it is fitted.

**Falling Leaf.** A manoeuvre in which an aeroplane in a gliding

attitude is made by the use of the controls to oscillate or swing, but with no apparent change of track. This manoeuvre is carried out by placing the aeroplane in a stalled position and allowing the spin to commence in one direction, then reversing the rudder action in time to stop the first turn of the spin. Owing to the aeroplane's stalled position it loses height with each oscillation.

**False Wing Rib.** See FORMER.

**Farad.** The name given to the unit of electrical capacity, out of compliment to Michael Faraday for his contribution to electrical science. By definition, a condenser has a capacity of one farad when a charge of one coulomb, i.e. a current of one ampere flowing for one second, raises it to a potential of one volt. In normal practice a farad is too large a unit so a micro-farad is used instead. One micro-farad equals one-millionth part of a farad.

**Fathom.** A unit used by sailors in measuring the depth of water, and equal to six feet. For example, a depth of six fathoms is the equivalent of thirty-six feet.

**Fatigue.** When a metal is subjected to fluctuating stresses it will, after a certain number of applications of the fluctuating load, suffer from an internal condition known as fatigue. The effect upon the material is to alter the crystalline structure and small cracks are liable to form on the surface, which will ultimately cause fracture. It can readily be demonstrated by experiment that fatigue failure will occur at stresses much lower than those of a static nature which the metal could safely carry.

The method of conducting a fatigue test is to fix a prepared

specimen in an apparatus which is capable of applying a predetermined, rapidly fluctuating stress and count the number of applications until fracture occurs. The test is repeated six or more times, using different specimens of the same metal, but the maximum stress in each instance is reduced. It will ultimately be found that below a given stress the material will withstand an infinite number of fluctuations without fracture.

**Fatigue Limit.** The stress which can be indefinitely repeated without failure of the material.

See also **FATIGUE**.

**F.B.** Letters used to denote fighter bomber. The letters are used as a prefix to the mark number of the aeroplane and denote its duty; for example, Spitfire F.B. IX.

**Feathering Propeller.** A propeller whose blades can be rotated through the coarse pitch to a position such that their leading and trailing edges lie in planes approximately parallel to the axis of the propeller shaft. The advantages of a full-feathering propeller are that the engine is stopped during flight, i.e. does not "windmill," and consequently a minor engine failure does not result in major damage being caused before the machine alights. The fact that the blades offer a minimum air resistance and the engine is stationary reduces the drag on the aircraft, thus making flight with the remaining engines easier.

**Fédération Aéronautique Internationale.** An international non-profit organization, formed in 1905, and to which thirty-eight nations belong, each having one representative. The object of the F.A.I. is to promote goodwill and understanding among the countries interested in aviation by fostering the development of international touring by air, by drawing up international regulations covering

aeronautical sports, and by safeguarding the material and moral interests of aviation in all countries.

**Feed Pipe.** A pipe leading the fuel or oil from the fuel or oil tanks to the engine.

**Felt.** A fabric composed of wool and hair, or wool and cotton, which is manufactured by intertwining the fibres under pressure.

**Ferrous Metal.** Metal which has an iron base, e.g. all classes of iron and steel.

**Ferrule.** Small metal or composition fitting fixed over the insulation at the ends of electric leads to prevent fraying. Sometimes used with rivets.

**Fescolizing.** This refers to the electrical depositing of metal. It differs from normal electro-plating as regards the interlocking between the base and the applied metals. The depositing is carried out in a cold bath, and it is claimed that perfect adhesion and cohesion is accomplished.

The metals usually deposited are chromium, cadmium, and nickel.

**Fighter Aircraft.** A type of aircraft so armed that it is used in normal military service for attack by the use of guns or cannon.

The name indicates speed, manoeuvrability, fighting characteristics or aggressiveness.

**Filler.** This is normally a paste, but may be a liquid composition, which is used for filling small indentations in wood prior to applying paint or varnish. It acts as a seal for paint or varnish when it is used on soft wood, and assists in the production of a very smooth finish when used on all woods.

**Filling Sleeve.** A sleeve which is attached to the envelope of an aerostat to which the gas filling hose can be attached.

**Fin.** An aerofoil attached to the rear of an aircraft approximately

parallel to the plane of symmetry. It affords directional stability.

**Fin Carrier.** This is a rigid frame which is attached to channel patches on the envelope of a non-rigid or semi-rigid airship or a balloon, to distribute the forces from a fin.

**Fineness Ratio.** The ratio of the length (measured parallel to the usual direction of motion) to the maximum diameter of a streamline body. The best value for the fineness ratio is four, because at lesser values the drag coefficient is considerably increased. When the ratio is greater than four there is a slight increase in drag, probably due to extra skin friction.

**Fins and Flashes.** These are defects in ferrous materials which are formed during the process of rolling the blooms into bars.

**Fire Extinguishers.** The type of fire extinguisher used in aircraft is usually one in which the inner sealed container is filled with fire extinguishing liquid under high pressure. It is actuated by striking a knob, vaporization then takes place, and the internal pressure forces the liquid through a nozzle.

**Firing Order.** The order or sequence in which the charges in the cylinders of an internal combustion engine are ignited. In order to reduce vibration to a minimum and to secure the smoothest torque at the shaft, the firing sequence should be arranged to occur at uniform intervals during the rotation of the crankshaft. All the cylinders are fired once in each two complete revolutions of the crankshaft.

Consider a nine-cylinder radial aero engine.

Angle between cylinders

$$= \frac{360}{9} = 40^\circ.$$

Each cylinder to be fired once in

two revolutions, hence firing interval

$$= \frac{720}{9} = 80^\circ.$$

If a firing interval of  $80^\circ$  is taken, then the firing order would be 1, 3, 5, 7, 9, 2, 4, 6, 8.

If there were an even number of cylinders in one bank, it is quite clear that it would not be possible to maintain a uniform firing interval.

When dealing with "in-line" engines the same principle is applied. A typical sequence for a six-cylinder in-line engine having cranks at  $120^\circ$  is 1, 4, 2, 6, 3, 5.

**Fish Tailing.** This is an alternative manoeuvre to side-slipping. The aeroplane side-slips first to port, then to starboard to lose height, thus shortening the landing glide.

**Fitting.** A term which refers to any one of the parts used in fabricating a structure. The most important fittings on aeroplanes are those which join two or more major assemblies, such as wing to fuselage.

The word is also used to describe the work of the "fitter," who is the tradesman who mates the parts of either an engine or an airframe.

**Fix.** The intersection point of two or more bearings on a chart or map which serve to determine the position of an aircraft. It is known as an absolute fix if the bearings intersect at a large angle.

**Fixed Aerial.** An aerial which is permanently fixed to two or more points on the structure of an aircraft in contradistinction to a trailing aerial which is wound out from the aircraft in flight, but wound in again before alighting.

**Fixed Gun.** A gun which is so attached to the structure of an aircraft that it can only be trained on the objective by manoeuvring the aircraft.

**Fixed Light.** A light used as a beam which is constant and uniform



in intensity when viewed from a definite position.

**Fixed Pitch Propeller.** A propeller which has a fixed unalterable angle of pitch on the blades. It is the older type of propeller. A "fixed pitch propeller" can only be efficient at a predetermined horsepower output and at one speed of flight.

**Flags (R.A.F. Officers).** A distinguishing flag is hoisted by an Air or other officer in command of a station. It is worn at the masthead whenever the ensign is hoisted at the peak. At a station the flag of the senior Royal Air Force officer only is worn at the masthead. The flags are for officers of the rank of Squadron-Leader and above, and are of various shapes with a light blue background and a dark blue edge, with red stripes.

**Flame Damper.** See INDUCTION FLAME DAMPER.

**Flame Trap.** A flame trap is fitted in the induction pipes and is similar in principle to a miner's safety lamp. This arrests the flame which may be caused by a backfire passing towards the carburettor, thus eliminating fire risk.

**Flange.** A stiffening portion of I-beam sections, channel sections, etc.

It is also the name given to the circular metal positioned at the end of a shaft or pipe to form a coupling.

**Flanging Machine.** A forming machine which bends the edge of plate or the ends of thin tubing to form a flange. This may be done in one or more operations.

**Flap.** A hinged or pivoted section attached to the rear portion of the main plane which can be moved downwards by a control mechanism operated, generally hydraulically or electrically, from the pilot's cockpit. The flaps on both sides of the plane of symmetry go down or up together, and by the same amount. When the

flaps are depressed the effect is to increase the effective camber of the upper surface of the wing as well as the concavity of the under surface, thus increasing the lift very materially. The consequence of this is that flaps can assist take-off as well as permit reduced landing speeds. There are special forms of flaps, one type of which allows the lower surface of the rear portion of the wings to swing down, leaving the upper surface intact. In another kind the rear portion of the lower main plane surface slides backward and downward, thus increasing the effective camber as well as increasing the wing area.

**Flare.** This refers to the outward curve of the hull towards the bow of a flying boat from the chine to the gunwale.

**Flash Point.** The temperature at which oil contained in a special apparatus gives off an inflammable vapour which will ignite when a light or spark is applied. The flash point of a lubricating oil may be quoted either as "closed flash point" or "open flash point"; in the former the oil is contained in a vessel having a lid, such as the "Abel" or "Pensky-Martens" flash point apparatuses, and in the latter the oil is in a shallow open vessel. The closed flash point is always a few degrees lower than the open.

**Flashing Light.** An intermittent light used as a beacon in which the duration of the bright period is less than the dark period.

**Flat Headed Rivet.** A rivet having a thin, circular disc head, used where a countersunk headed rivet is not suitable, or where the head is near to another part of the structure which does not leave sufficient clearance for a thicker head.

**Flat Keel.** A keel of a hull or float so constructed that its major axis in cross-section is in the horizontal plane.

**Flat Spin.** When an aircraft is spinning the actual path is a vertical spiral, the axis of which is called the axis of spin. In a spin, the main planes are at a high angle of attack because the aircraft is moving almost vertically downward, and therefore the relative airflow is almost vertically upward. Even though the nose is pointing downward, the wings are in a stalled condition. When the longitudinal axis of the aircraft is between about 20° and 40° to the horizontal it is said to be in a flat spin. Under these conditions the angle of attack may be as much as 70°, hence the wings are badly stalled even compared with the conditions of a normal spin when the angle of attack is only about 35°.

**"Flat Spot."** This is a term which refers to what may be described as hesitation in responding in an internal combustion engine when the throttle is opened from the slow running position.

**Fleet Air Arm.** That arm of the Navy which deals with flying.

**Flettner Rotor.** The principle of the Flettner rotor is that when a cylindrical surface is rotated in an airstream, a force is exerted at right angles to the axis of the rotor. This phenomenon is sometimes referred to as the Magnus-effect. The explanation is that the air in close proximity to the rotating surface is carried round with it due to friction, the effect becoming less the farther the layer of air is from the cylinder. If a stream of air strikes such a rotating cylinder, the airstream will be deflected so that at one side of the cylinder a pressure is set up, whilst on the opposite side the air pressure is reduced. The consequence of this difference of pressure is to cause a force in a manner similar to the "lift" of an aerofoil. Though an experimental ship was propelled by

Flettner rotors, the principle has not yet been tried in connexion with aircraft.

**Flick Roll.** An aerobatic manoeuvre in an aeroplane consisting of a rapid roll about the longitudinal axis produced by a quick movement of the controls. The motion is maintained by autorotational couples on the wings.

**Flight Altitude.** The vertical distance from a given datum, generally sea level, to an aircraft in flight. It is expressed in feet or metres.

**Flight Lieutenant.** A commissioned rank in the Royal Air Force equivalent to a Lieutenant in the Royal Navy and a Captain in the Army. The badge of this rank consists of two rings of braid round the cuff of the sleeve.

**Flight Officer.** A commissioned rank in the Women's Auxiliary Air Force comparable with that of a Flight Lieutenant in the Royal Air Force and designated by similar badges of rank.

**Flight Path.** The course or path of the centre of gravity of an aircraft in relation to the air through which it passes. It also refers to the trajectory of a bomb or projectile.

**Flight Path Angle.** The angle between the flight path of the aeroplane and the horizontal.

**Flight Path Recorder.** An instrument which records the angle of the flight path of an aeroplane in relation to the horizontal.

**Flight Sergeant.** A non-commissioned rank in the Royal Air Force comparable with a Chief Petty Officer in the Royal Navy and Squadron Quartermaster Corporal (Household Cavalry) or Squadron, Battery, Troop or Company Quartermaster Sergeant, Colour Sergeant, Staff Corporal (Household Cavalry) or Staff Sergeant, in the Army.

The distinguishing badge consists of three braid chevrons surmounted by a brass crown.

**Flight Ways.** Flight ways are the air spaces of carefully defined dimensions at both ends of a runway within which there must be no obstructions to flight.

**Float.** A watertight body attached to an aircraft in order to give it buoyancy and stability on water. It enables the aircraft to take off and alight on water.

It also refers to that part of a carburettor which maintains the correct fuel level in the float chamber.

**Float Displacement.** The total volume of water which is displaced by a seaplane float or hull.

**Float Plane.** A seaplane with floats.

See also **FLOAT SEAPLANE**.

**Float Seaplane.** A seaplane whose means of support on water is by floats.

**Floating Ailerons.** Ailerons which are operated in the normal manner but are connected so that they are free to take up an equilibrium position.

**Floating Gudgeon Pin.** A gudgeon pin so designed that it is free to rotate both in the small end of the connecting-rod and in the piston.

**Floating Island.** See **SEADROME**.

**Floodlight.** A device which has been specially designed to illuminate the surface of a landing area.

**Flotation Gear.** An emergency appliance attached to a landplane to prevent sinking in water.

**Flow Meter.** See **FUEL FLOW METER**.

**Fluid Resistance.** The resistance which is met when a solid body is moving through a fluid. It is the amount of mechanical energy which must be applied to the solid body to move it through the fluid. When a solid body is moving through the air there is a corresponding air resistance.

**Flush-type Riveting.** The riveting of two pieces of material together so that the rivet head is flush with the outside of the metal. It is normally used on the outside of fuselages or wings. This type of riveting is often obtained by cutting a countersink into the metal and using a countersunk rivet.

**Flutter.** An oscillation of definite period but unstable character which may be set up in any part of the aircraft structure due to the action of aerodynamic forces upon the structure.

**Fluvial Machines.** This refers to the type of seaplane and amphibian which in normal service is intended to take off from or alight on calm water only.

**Flux.** A mixture which may be liquid, powder, or solid, which is used for soldering or welding, and which at the correct temperature will unite with the oxides of the metal and thus clean the weld. All metals at high temperature become oxidized. These oxides must be removed, otherwise the weld will be filled with oxide particles and the work will be a failure. With the exception of steel, most of the common metals have a lower melting point than their oxides. The effect of the flux is to lower the melting temperature of the oxides. The molten oxides then float on to the top, leaving clean metal for welding.

**Flying Boat.** A seaplane supported by a hull or hulls when resting on the surface of the water.

**Flying Bomb.** This is an explosive-carrying crewless aeroplane which has a propulsion unit of the thermodynamic duct type. It is of all-metal construction and is a mid-wing monoplane. The fuselage is divided into a number of sections. The nose section is merely a light metal fairing behind which is a warhead of similar construction which contains the explosive. This

section is joined to a fuel tank immediately forward of the leading edge of the main plane. Behind this section are two large spherical compressed air bottles, the air of which is used to meter the fuel for delivery to the propulsion unit. The next section contains an automatic pilot.

See also **ATHODYD**; **THERMODYNAMIC DUCT**.

**Flying Machine.** Any aerodyne which is driven mechanically.

**Flying Officer.** A commissioned rank in the Royal Air Force equivalent to a Sub-Lieutenant in the Royal Navy or a Lieutenant in the Army. The badge of this rank consists of one ring of braid round the cuff of the sleeve.

**Flying Position.** The attitude of an aircraft when the lateral and longitudinal axes are parallel to the earth's surface.

**Flying Speed.** Any air speed within the normal speed range of an aircraft.

**Flying Weight.** The all-up weight of an aircraft at the commencement of a flight.

**Flying Wing.** A type of aeroplane in which the wing structure is the major portion of the aeroplane. The normal type of fuselage is eliminated and the tail may be attached to the wing by means of outriggers or tail booms. Attempts are being made to eliminate the tail and to design a wing which will give both directional and longitudinal control.

**Focal Length.** This is the distance the film is away from the optical centre of the lens. The lens with the greatest focal length will give the largest image of the object being photographed.

**Fog.** Fog consists of numerous droplets of water; these are so small that they cannot easily be distinguished as water by the naked eye. The term also refers to smoke held in suspension in the air.

Colloquially the term "fog" is used to indicate that objects cannot be seen beyond a defined distance.

See also **APPENDIX B**.

**Föhn.** A wind which is warm and dry and blows down the northern slopes of the Alps when the general wind comes over the mountains. The term is often used for winds under similar conditions in other localities than the Alps.

**Folding Wings.** A type of aeroplane in which the wings are so constructed that they can be folded back so as to occupy less space when stored away in the hangar. This device is normally used for aeroplanes on aircraft carriers or warships.

**Foot Pound.** A unit of work. It is the amount of energy required to raise one pound, vertically, through a distance of one foot.

**Force.** A force is the action which alters the state of motion or position of a body, i.e. it is any action which tends to produce or alter motion. A force has the following three characteristics: (a) magnitude, (b) direction, and (c) point of application.

**Forced Fit.** Refers to parts which after being specially selected are held in a fixed position after assembly. Depending upon the size of the parts and the types of material employed, forced fit clearances range from a low limit of 0.00075 in. to a high limit of approximately 0.009 in.

**Forced Landing.** Landing necessitated because of mechanical failure or condition such as bad weather, lack of fuel, etc., which makes continued flight either impossible or dangerous.

**Fore and Aft Level.** An instrument which denotes the direction of the resultant force on an aircraft in its plane of symmetry. It is sometimes called a longitudinal clinometer.

**Fore Body.** That part of hull or float usually forward of the main step.

**Forecast.** A statement of the meteorological conditions likely to be experienced during a definite period at a given place. It indicates what is expected over a given area or along a given route. The information normally given is—

(a) The direction and force of the wind on the earth's surface.

(b) The direction and velocity of the upper wind at defined heights.

(c) The amount of sky which may be covered with cloud and the height of the lowest cloud.

(d) Rain, if any.

(e) Visibility.

(f) The probability of any special phenomena such as thunderstorms, squalls, etc.

**Forging.** Parts manufactured by placing the pre-heated material under the repeated blows of a hammer and forcing the material to conform to the shape required.

**Form Drag.** This is sometimes known as pressure drag, and is that part of the drag due to the resolved components of the pressures normal to the surface of an aerofoil.

**Formation Flying.** A type of flying used in war whereby the pilots of each machine are in such a position that they can protect each other during attack and concentrate their fire when attacking.

**Former.** A rib which is used to maintain the shape of the aerofoil. It frequently, in a wing, consists of a strip of wood extending from the leading edge to the front spar.

**Four Cycle Engine.** The usual type of internal combustion engine which requires two revolutions of the crankshaft to complete the four strokes: (a) admission of the charge of combustible mixture into the cylinder; (b) compression of the charge in the cylinder; (c) the burning of the charge in the cylinder;

and (d) exhausting the burnt charge from the cylinder. Sometimes known as the OTTO cycle.

**Fractional Process.** The first method to be developed to produce what is known as "straight run petrol." Crude oil is heated to a moderate temperature under normal atmospheric conditions and the various hydrocarbons are progressively vaporized. The more volatile compounds evaporate first, and the other compounds of a less volatile nature follow. The vapours of each are then led through condensers to be converted to the liquid state.

**Fracto-cumulus.** Small cumulus clouds which have ragged tops and are continually changing their shapes.

**Fracto-stratus.** A stratus cloud broken up in irregular fragments of a ragged form.

**Fragmentation Bomb.** A bomb designed to hurl fragments of metal, for use against ground troops.

**Frame Longitudinal.** That portion of the longitudinal of an airship which forms a component member of the transverse frame.

**Frames.** The fabricated parts which maintain the form and the shape of the structure of an airframe.

**Free Balloon.** A balloon whose ascent and descent are controlled by use of ballast or by releasing some of the encased gas. Its direction of flight is dependent on the wind. Balloons of this type are normally of spherical shape.

**Free Balloon Net.** A net which passes over the envelope of a free balloon, and from which the basket is suspended.

**Free Flight.** A power-driven aerodyne is in free flight when it is maintained in the air by its own power on a level or rising path.

**Free Gun.** A gun which is so mounted in an aircraft that it can be

trained on the objective independently of the line of flight of the aircraft.

**Free Parachute.** A parachute in which the pack is secured only to the body of the user. In this type of parachute the release is dependent on the operator controlling the opening of the parachute.

**Freeboard.** This refers to the dimension vertically upwards from the load waterline of a flying boat hull, either to the gunwale or to the lowest opening through which water could enter.

**Freedom of Innocent Passage.** Article 2 of the Air Convention provides that "Each contracting State undertakes in time of peace to accord freedom of innocent passage above its territory to the aircraft of the other contracting States, provided that the conditions laid down in the present Convention are observed."

**Freezing Rain.** Rain which freezes on to objects as soon as it strikes them. After freezing on the object it is termed "glazed frost."

**Frequency.** This term is used to indicate the number of times the movement of a vibration occurs. Frequency is usually referred to in either cycles per minute or cycles per second.

**Frise Ailerons.** Ailerons so designed that the leading edge protrudes below the lower surface of the wing when the trailing edge of the aileron is raised in order to increase the drag of that wing. When the aileron is lowered the leading edge does not protrude above the upper wing surface.

**Front.** This is the line or narrow belt marking the boundary, at the earth's surface, between two air masses of different characteristics. The passage of a front is usually marked by a change in wind and weather.

**Frost.** A condition in which small

frozen drops of dew freeze into crystalline ice structure when the temperature is below 32° F.

See also GLAZED FROST; RIME.

**Froude's Law.** This law states that to obtain a water flow on a model similar to that of full scale, the model should be towed in a water tank at a speed equal to the full-scale speed multiplied by the square root of the scale of the model. Thus for a one-tenth scale model of a hull travelling at 100 m.p.h., the correct speed for a model test would

$$\text{be } 100 \times \sqrt{\frac{1}{10}}.$$

**Fuel.** The fuel used in aircraft engines consists of the mixture of volatile fractions of the paraffin, naphthene, and aromatic series of hydrocarbons.

**Fuel Bypass Regulator.** A device for regulating the fuel pressure in the carburettor float chamber.

**Fuel Contents Gauge.** See FUEL LEVEL GAUGE.

**Fuel Flow Meter.** An instrument which indicates the rate of consumption of fuel. It is used principally for test purposes but occasionally fitted to aircraft so that the crew can estimate the rate of consumption of the fuel and adjust the engine or engines to the most economical speed.

**Fuel Injection.** The injection of a calibrated quantity of fuel into the cylinder of an internal combustion engine at a predetermined moment. It injects the fuel directly into the cylinder against compression. This system is used on Diesel and compression ignition engines, and occasionally on the normal petrol internal combustion engine.

**Fuel Injector.** An injector designed to deliver continually a calibrated quantity of fuel into each cylinder of an internal combustion engine. The order in which the injection takes place to the cylinders

must be the same as the firing order of the engine.

**Fuel Level Gauge.** A gauge used to determine the amount of fuel in a tank. There are many types, varying from the simplest form, which consists of a cork float, to the hydrostatic type.

**Fuel Oil.** The fuel commonly used in Diesel engines. A petroleum derivative more easily obtained than petrol. It is sometimes known as distillate.

**Fuel Pressure Gauge.** This is a type of gauge which is used for indicating the pressure in the fuel system. It is normally of a Bourdon type mechanism.

**Fuel Pump.** A pump used to supply fuel to the carburettor of an internal combustion engine, or to transfer fuel from one tank to another. The pump is similar to that used for lubricants.

**Fulcrum.** The point about which a lever rotates.

**Full Annealing.** The heating of a metal above the critical temperature followed by slow cooling through the range. Full annealing results in greater ductility, increased toughness, and the relief of residual stresses.

**Full Rudder.** The application of the rudder to the greatest extent. This means that angular movement of the rudder is complete about its hinge.

**Fuller's Earth.** A soft clay used as a filtering medium for clarifying oil, greases, etc.

**Funicular Polygon.** The figure which is formed by the drawing of a force diagram. Each of the sides of the polygon is determined by the reproduction of the direction and magnitude of the forces. The figure may be drawn to any convenient scale.

**Fuse.** A piece of wire of predetermined diameter, size, and melting point. It is used as a safety device in electric circuits. When the current attains too great a value the fuse wire melts and the circuit is broken.

**Fuselage.** The main structure of an aerodyne to which are attached the wings and tail unit of an aeroplane.

**Fusion Welding.** A method by which the edges of two metals are fused together by using a welding flame. A welding rod is sometimes used to assist in filling the weld.

## G

**G or g.** A symbol used to denote gravity.

**Gale.** A wind of or exceeding force "8" on the Beaufort scale.

**Galvanized Iron.** Iron or steel sheets which are coated with zinc by dipping the sheets in a bath of molten metal. The object of the zinc coating is to protect the iron against corrosion.

**Galvanometer.** An electrical instrument which has been designed to measure the intensity or voltage of an electric current.

**Gamma Rays.** The rays which are emitted from radium or its associates. The wavelengths are similar to that of X-rays.

See also GAMMAGRAPH.

**Gammagraph.** A photograph which is produced by the use of gamma rays.

**Gap.** The distance between a plane and the one immediately above or below it measured along a line perpendicular to the chord of the upper plane at any point of its leading edge.

**Garboard Strake.** In a hull or float this is the row of plates next to the keel on either side.

**Gas Bag.** The gas-containing section of a rigid airship.

**Gas Bag Alarm.** A device fitted to the gas-containing unit of a rigid airship which indicates when a predetermined pressure has been attained.

**Gas Bomb.** A type of bomb used to discharge gases with the object of causing distress among enemy personnel.

**Gas Hood.** A hood in the outer cover of a rigid airship through which any gas which may be inside the hull can escape.

**Gas Main.** A hose made of fabric which passes through the length of

a rigid airship and has branches to the gas bags for inflation purposes.

**Gas Ring.** See PISTON RINGS.

**Gas Starter.** A device by means of which an engine is rotated for the purpose of starting it. A combustible gas mixture under pressure is supplied to the cylinders during the power stroke.

**Gas Trunk.** A duct situated between the gas hood and the gas bag valve of a rigid airship.

**Gas Volume.** The volume of the gas contained in an airship envelope under standard atmospheric conditions.

**Gassing.** The operation of recharging a balloon with gas. It may be done to make up gas lost or to increase its purity.

**Gauge.** A suitably shaped tool that has been finished to standard dimensions and used to check the finished dimensions of parts, and to measure accurately distances between various parts after they have been erected. Gauges are made from special tool steel and are accurate only at a specified workshop temperature.

The term also refers to the thickness of a material. The gauge of a material is in decimal or fractional parts of an inch, but in some instances the thickness is quoted as a number. This number is sometimes related to or the same as the thickness of the material in decimal parts of an inch.

**Gauge Pressure.** The pressure as registered on a pressure gauge. It is the pressure generated by the pump above atmospheric pressure, which is not registered.

**Gear-driven Supercharger.** See DIRECT DRIVE SUPERCHARGER.

**Geared Propeller.** A propeller driven by gear wheels, generally at



fewer revolutions than the engine revolutions.

**General Inference.** A general description of the meteorological situation inferred from the pressure distribution shown on a synoptic weather chart at a definite time, together with changes in progress. It also contains a statement of the type of weather likely to be experienced as a result of these changes over a particular area.

**Generated Acetylene Gas.** Acetylene gas which is generated by a carbide and water type generator.

See also ACETYLENE.

**Generator.** An electrical machine for converting mechanical energy into electrical energy.

See also DUAL PURPOSE GENERATOR.

**Geodetic Lines.** Lines upon a curved surface which are the shortest distance between any two points on the surface.

**Geodetic Structure.** A geodetic line is the shortest distance between two points on a curved surface, and this type of structure has, in addition to increased structural strength, the advantage of aerodynamic cleanness. The geodetic members are arranged spirally around the main longitudinal members. The framework may be covered with plywood, sheet metal, or fabric.

**Geographic North.** See TRUE NORTH.

**Geographical Co-ordinates.** A system of circles on the earth's surface used to indicate the positions or locations of places on the surface of the earth by referring to these circles.

**Geographical Meridian.** The meridian of the earth which passes through the earth's geographical poles. A true north and south line.

**Geographical Mile.** The length of an arc of one minute measured on the earth's surface at the Equator.

It is 6087.2 ft. This measurement of length is seldom used.

**Geographical Poles.** The points at which the axis of the earth meets the surface of the earth. These points are known as the North and South Poles.

**Geometrical Pitch of a Propeller.** The distance that a propeller would advance in one revolution if there were no slip.

**German Silver.** The name given to a group of copper-nickel-zinc alloys. It does not corrode easily and has a very high electrical conductivity.

**Gibli.** See QIBLI.

**Girders.** See AXIAL GIRDER; CRUCIFORM GIRDER; BAY LONGITUDINAL; FRAME LONGITUDINAL; MAIN LONGITUDINAL.

**Glacier Breeze.** A cold breeze which blows down the side of a glacier.

See also KATABATIC WIND.

**Glaze.** A term sometimes used to refer to a smooth coating of ice on objects due to the freezing of rain. Generally termed glazed frost.

**Glazed Frost.** A layer of smooth ice which is formed by rain falling on exposed objects when the temperature of the objects is below freezing point.

**Glide.** A descent at a normal angle of attack and without engine power, the propeller thrust being replaced by part of the force due to gravity acting along the line of flight.

**Glider.** An aircraft heavier than air but without an engine.

**Gliding Angle.** The angle between the horizontal and the path along which an aeroplane descends at normal flying speed, but without propeller thrust.

**Gliding Certificates.** No licence is required for the flying of gliders, but certificates of competency are issued by the Royal Aero Club under the same conditions as laid

down by the International Aeronautical Federation. Three grades of certificates are available—Classes A, B, and C, C being the highest category.

For Certificate A the candidate must make a flight of at least 30 seconds' duration, followed by a normal landing. In addition, the candidate must previously have made at least twelve glides or must hold an aeroplane pilot's licence.

For Certificate B the candidate must have made a flight of at least one minute's duration with two curves in the form of an "S," and ending with a normal landing. The candidate must have previously made two separate gliding flights, each of not less than 45 seconds.

For Certificate C, a candidate must have made a flight of not less than five minutes' duration at a height greater than the point of departure and ending with a normal landing.

These certificates are issued at a fee of 5s. They do not require renewal.

In all the above tests the candidate must be under observation and must be alone in the glider.

**Gliding Range.** In a normal glide this is the maximum distance that can be reached from a defined height by an aeroplane.

**Glue.** This term covers a large number of materials which are used as adhesives. Ordinary glue is made from clippings of animal hoofs, hides or bones. Albumen glues are prepared from blood or casein. Marine glues are usually made from solutions of resins.

**Glycerine.** A thick, sweet, oily liquid consisting of carbon, hydrogen, and oxygen formed by the decomposition of fats. It is used in some cases as an anti-freeze solution in liquid-cooled engines.

**Gnomonic Projection.** A map or chart made by establishing a refer-

ence point in the centre of the earth and projecting lines at angles of 30 degrees to a flat surface which is tangential to the earth's surface, the centre of the chart being on the radius of the earth. On gnomonic projections all great circles on the earth's surface will therefore appear as straight lines. Gnomonic maps are known as great circle maps, and are used when flying on great circle courses.

**Go Gauge.** A gauge which must go on or into the part for which it is intended without being forced on or in. If these conditions are met the part is within the prescribed allowance.

**Go or Not Go Gauge.** This gauge is really two gauges combined, one for the minimum size and one for the maximum size. The "go" gauge is made to the high limit and the "not go" to the low limit.

**Gore.** A shaped fabric segment of the envelope of a balloon, airship, or parachute. Usually oval in aerostats and triangular in a parachute.

**Gouge Flaps.** A type of flap operated by a worm drive. The flap runs in guide rails fixed to the under part of the main supporting surface.

See also FLAP.

**G.R.** Letters used to denote general reconnaissance aircraft. The letters are used as a prefix to the mark number of the aeroplane and denote its duty; for example, Whitley G.R. VII.

**Gradients.** The gradients commonly discussed in meteorology are the horizontal gradient of pressure and the vertical gradient of temperature.

See also PRESSURE GRADIENT; LAPSE RATE.

**Grain.** A unit of weight,  $\frac{1}{7000}$  of a pound avoirdupois; equal to 0.0648 gram.

In metallurgy it is the arrangement of the structure of metals

which have been rolled. When making bends in sheet metal the grain should always run in the direction of the bend.

**Gram.** The principal unit in the metric system of measurements for weights.

**Graphite.** A form of carbon sometimes used as a lubricant.

**Gravity.** A force acting toward the earth's centre. The weight of any object is due to gravity and this force produces an acceleration of the object at 32.2 ft. per sec. per sec.

**Gravity Tank.** A tank from which the fuel to the engine is supplied solely by gravity.

**Great Circle.** A circle shown on the surface of the earth by a plane surface which passes through the centre of the earth, or any circle on the earth's surface which divides the world into two equal parts. All meridians of longitude are halves of great circles.

**Great Circle Course.** A course which follows a great circle line and includes the points of departure and arrival.

**Gregale.** A strong wind in the Ionian Sea and neighbouring parts of the Central Mediterranean which usually blows from the north-east during the winter period.

**Grid Ring.** This is a ring that rotates on the verge ring of a compass which is intended for reading the course of an aeroplane. The grid ring is arranged so that it can be accurately aligned by hand with the magnets, and the course is then indicated on a scale on the grid ring. As the scale is not on the moving magnet system, this means a reduction in weight of the magnet system, and the difficulties of suspension and damping are thus reduced.

**Grommet.** A small ring, generally of cord but sometimes of metal, used as a local reinforcement in fabrics.

**Gross Dry Weight.** The net dry weight of the engine with the addition of the propeller hub complete, starting units, exhaust branch pipes and manifolds, primers, air intakes, accessories and controls, fuel and oil filters. It excludes the fuel, oil, radiator and liquid, and interconnecting pipes, tanks, exhaust tail pipe, and engine instruments.

**Gross Lift.** The buoyancy of an aerostat under standard conditions of density and purity.

**Gross Weight.** The all-up weight of an aeroplane when fully loaded.

**Ground Cloth.** A sheet of canvas or other suitable material, which during inflation and deflation of an aerostat is placed underneath it for its protection.

**Ground Engineer.** An engineer authorized to certify that an aircraft is safe for flying or that the parts thereof are in accordance with the regulations which are in force at that time.

See also GROUND ENGINEERS' LICENCES.

**Ground Engineers' Licences.** These licences are issued to competent persons for the purpose of inspecting an aircraft and aero engines as being safe for flight, and for the inspection and approval of repairs, replacements and overhauls to aircraft and aero engines. They may be licensed in any or all of the five categories, which are as follows—

Category A. For inspection of aircraft before flight.

Category B. For inspection of aircraft after overhaul.

Category C. For inspection of aero engines before flight.

Category D. For inspection of aero engines after overhaul.

Category X. For special duties, including instrument repair and calibration, magneto overhaul and testing, parachutes, etc.

Personnel requiring the certificates may be of either sex, and are

required to be not less than 21 years of age. They must have had practical experience in the duties for which the licence is required. It is not usual to issue a licence unless they have had at least two years' experience. An examination is arranged.

The licences are issued at a fee of 21s. and are valid for one year. They are renewable at a fee of 5s. providing evidence is available of recent practical experience in the specific duties.

**Ground Fog.** Shallow fog extending only a few feet above the surface of the ground and caused by cooling of the earth due to radiation.

**Ground Lag.** The horizontal distance at the surface of the earth between the vacuum flight path and the normal flight path of a bomb.

**Ground Marks.** This is a system which is laid down in the Convention relating to the Regulation of Air Navigation and is as follows—

Marks on the ground and on the roofs of buildings shall refer numerically and geographically to the sheets of the local international aeronautical maps. For this purpose each mark will show—

(a) The abridged number which designates the sheet within which it lies.

(b) The half rectangle whose short side shall be orientated north-south and which shall be open towards the opposite half of the unit sheet.

(c) A dot indicating the approximate position of the mark on the north or south half of the corresponding unit sheet.

The numbers forming the abridged number of the sheet shall be placed close to the frame at the top, bottom or sides, but not inside.

The names of aerodromes open to public use shall be marked on the ground by roman letters in white, of the following dimensions—

Length of each letter 20 ft.

Width of each letter 16 ft.

Space between each letter and at each end of name 16 ft.

Width of trench forming stroke of each letter 3 ft.

**Ground Performance.** This implies the landing, taking off, and taxi-ing characteristics of an aeroplane.

**Ground Speed.** The rate at which an aircraft is travelling in respect to the surface of the earth. Ground speed is determined by the time required to pass over a defined course. It is affected by the velocity and direction of the wind.

**Ground Starter.** Any device which is not carried in the aircraft for starting an aero engine.

**"Ground Strafing."** A term given to low-flying attacks on ground targets.

**Ground Wire.** A cable which is led from a winch through the mooring attachment at the top of a mooring tower. The cable is connected with the main mooring wire when this is lowered from the airship.

**Group.** An R.A.F. formation under a Command and responsible for the administration of lower units, such as squadrons.

**Group Captain.** A rank in the Royal Air Force equivalent to Colonel in the Army and Captain in the Royal Navy. The badge of this rank consists of four rings of braid round the cuff of the sleeve.

**Group Officer.** A rank in the W.A.A.F. similar to that of Group Captain in the Royal Air Force, and designated by similar badges of rank.

**Gudgeon Pin.** The pin which attaches the piston to the connecting-rod in an engine.

**Guild of Air Pilots and Air Navigators of the British Empire.** This Guild was founded in October, 1929. The object is to promote the consideration of all questions affecting, and to protect by all proper

legal methods, the interests of its members and the profession of commercial aviation. There are two grades of membership—members and associates.

**Gum Arabic.** A substance which is used for adhesives and as a binding and filling material. Sometimes known as acacia gum.

**Gun, Camera.** See CAMERA GUN.

**Gun, Fixed.** See FIXED GUN.

**Gun, Free.** See FREE GUN.

**Gun Heater.** An electrical device which is fitted to a gun in order to maintain a suitable temperature for operation in the breech mechanism.

**Gun Metal.** A bronze containing about 88 per cent copper, 10 per cent tin, and 2 per cent zinc. Used for casting.

**Gun Mounting.** A fitting in an aircraft on which a gun is mounted.

**Gun Tube.** See CLIMBING SHAFT.

**Gunwale.** Sometimes spelt gunnel. It is the upper edge of a ship's side.

**Gusset.** A fitting that is used to strengthen corners in a structure. Gussets may be of any shape, but are generally triangular. They may be welded, bolted, riveted, etc.

**Gust.** A rapid brief increase in the velocity of the wind. Most winds near the earth's surface resulting from mechanical interference display alternate gusts and lulls.

**Gutta Percha.** A gum which is obtained from several types of trees. It is a very pliable substance but is not elastic. Used as a substitute for rubber for insulation purposes.

**Gyro Plane.** A flying machine whose main support in flight is derived from the reaction of the air on one or more revolving rotors.

**Gyroscope.** A gyroscope consists of an accurately balanced flywheel, carefully mounted, which, as long as the wheel is revolving at high speed, tends to remain in the same position and plane of rotation.

**Gyroscopic Level.** An instrument for indicating the angle between the true vertical and the normal axis of an aircraft by the employment of a gyroscope.

**Gyrostat.** This is a modification of the gyroscope and is used to illustrate the dynamics of rotating bodies.

## H

**Haar.** A name used locally in Eastern Scotland for a sea fog.

**Haboob.** A disturbance which occurs in the Sudan during the rainy season. It is usually of the line squall type and accompanied by a dense sand storm.

**Hague Rules (Proposed).** At the Hague in 1922, a commission of jurists of the United States, Great Britain, France, Italy, Japan, and the Netherlands investigated a code for air warfare. It remains a draft, never having been converted into an international convention.

**Hail.** Precipitation in the form of balls or irregular lumps of ice, often of considerable size. Hail falls almost exclusively from cumulo-nimbus clouds and is generally associated with thunderstorms.

**Hail Storms.** Storms which occur only with large cumulo-nimbus clouds. Hail storms are due to the rapid rising and falling of air currents.

**Half-beam.** Transverse section of hull or float from the centre line outboard. (Sometimes referred to as the half-breadth.)

**Half-breadth Plan.** A technical term used in hull and float construction. It denotes half-sections in a horizontal plane at the water-line.

**Half-roll.** A 180° roll of an aeroplane about its longitudinal axis. It may be either from normal level flight to an inverted position or vice versa.

**Halo.** A name for optical phenomena caused by ice crystals in the atmosphere. The most common of the phenomena is the halo surrounding the sun or moon.

**Hand Inertia Starter.** An internal combustion engine starter which utilizes a hand crank to start a flywheel spinning. The flywheel is

accelerated to the best obtainable speed, the crank handle removed quickly from the shaft, and the clutch used immediately to engage the engine and flywheel. The operation of engaging the clutch may be by a person in the cockpit, or it may be so arranged that the person turning the crank can operate the clutch.

**Hand Starter.** A hand crank used on comparatively low horse-power aircraft engines. The hand starter is geared to the crankshaft through reduction gears.

**Hand Starting Magneto.** An auxiliary magneto fitted with a hand crank. This magneto is hand cranked to obtain a hot spark while starting the engine. The hand starting magneto makes use of the normal ignition wires to the spark-plugs for delivering its spark.

**Handley Page Slat.** The Handley Page slat is an automatic control mechanism for opening and closing a slot, generally on the leading edge. The slat moves forward just before the stall, opening the slot. This allows the airstream to flow through the slot and steadies the flow over the aerofoil at lower flying speeds.

**Handling Frame.** A framework which can be temporarily attached to the underside of an airship. It is designed to assist the landing party when handling the aerostat.

**Handling Guy.** A rope which assists the landing party in handling an aerostat when being landed.

**Handling Rails.** Tracks fitted in an airship shed and which extend to the landing area to facilitate the use of trolleys for attachment to the handling guys of an airship.

**Hangar.** A shelter or building specially constructed for housing aircraft.

**Hardening (Aluminium Alloys).** Hardness in aluminium alloys is obtained by heat-treatment or by cold-working.

See also **HEAT-TREATMENT**; **COLD-WORKING**.

**Hardening (Steel).** Steel if heated to slightly above the critical temperature followed by rapid quenching in oil or water becomes hard. Carbon is the important constituent for this, so the carbon content of the steel normally determines the extent to which steel can be hardened. Mild steel does not harden.

**Hardness.** Hardness is a term which denotes the ability of a metal to resist permanent deformation.

**Hardness Test.** A test which is carried out to investigate the quality of a material and the effects of heat-treatment when it is not desired to make a tensile test.

The most common hardness test is the Brinell; this is performed by pressing a hardened steel ball into the material at a definite load for 15 seconds.

**Harmattan.** A wind prevalent in Western Africa during the dry season, that is, from November to March. It is a north-east wind, and carries with it great quantities of dust from the Sahara.

**Harness.** See **PARACHUTE HARNESS**; **SUTTON HARNESS**.

**Haze.** A lack of clearness in the atmosphere caused by the presence of solid matter such as dust, smoke, or salt particles, the latter left by evaporated sea spray.

**Haze Top.** The upper boundary of a layer of haze. This may attain a considerable height.

**Head Resistance.** See **DRAG**.

**Head Wind.** A wind which blows parallel but in the opposite direction to the line of flight of an aircraft and consequently reduces its ground speed.

**Heading.** The direction in which the aeroplane is pointed. It may

be a true, magnetic, or compass heading.

**Heap Clouds.** Clouds of a vertical structure. Usually the height is between 5000 ft. and cirrus level, i.e. about 25,000 ft.

**Heat Engine.** A mechanical device for converting the heat energy in the fuel into mechanical energy. Owing to inevitable losses which occur during the process, only a proportion of the heat supplied to the engine is utilized. The ratio of the heat input to the heat turned into mechanical work is termed the thermal efficiency, which for an aero engine averages about 25 to 30 per cent.

**Heating Muff.** A chamber fitted round an exhaust pipe to collect hot air for transmission to other parts of the aircraft, such as the carburettor.

**Heat-treatment.** An operation or a number of operations upon metals or their alloys which consists of the heating or cooling of the material in order to obtain the ideal state for any particular use. Annealing, hardening, normalizing, and tempering are types of heat-treatment. Heat-treatment of metals consists of the following operations: (1) Heating the metal to its critical temperature; (2) maintaining the metal at the critical temperature for a sufficient period for the heat to penetrate thoroughly; (3) cooling the metal at normal workshop temperature or in oil, water, or air.

**Heavier-than-air Aircraft.** Aircraft which depends upon its motion through the air to obtain lift.

**Heavy-handed.** A colloquial term used to denote the handling of the controls of an aeroplane in a clumsy or heavy manner.

**Hecto.** Prefix meaning 100 in the metric system of measurements.

**Hedge-hop.** A colloquial term which refers to an aeroplane flying very close to the ground.

**Height Computer.** A device for converting indicated to true altitude. This instrument takes into consideration the density factor.

**Height, Equilibrium.** See EQUILIBRIUM HEIGHT.

**Height Finder.** A stereoscopic optical instrument used with anti-aircraft guns which indicates the height at which an aeroplane is flying.

**Height, Pressure.** See PRESSURE HEIGHT.

**Helicogyre.** An interesting though unsuccessful type of helicopter which was first developed in France in 1926. It had a four-blade lifting screw, and at the top of each of two of the blades was a small 33-h.p. engine which caused the lifting screw to rotate. A 50-h.p. engine with a tractor propeller was used for forward motion.

**Helicopter.** A type of flying machine designed for vertical ascent. Its support in flight is normally derived from aerofoils mechanically rotated horizontally about an approximately vertical axis.

**Helium.** One of the chemical elements, symbol He. It is the second lightest gas, is colourless, odourless, and has a specific gravity of 0.1368. It is employed in electric lamps and radio tubes because of its high heat conductivity. Because it is non-inflammable and very light it is used for filling balloons. Helium can be obtained from the atmosphere, but comes mainly from natural gas.

**H Engine.** An engine whose cylinders form in end view a shape like a letter H.

**Heptane.** One of the members of the hydrocarbon or paraffin series. It contains seven carbon and sixteen hydrogen atoms in each molecule. It is considered to have an octane rating of zero because it causes an engine to knock when used as a fuel.

**H.F.** Letters used to denote high

altitude fighter. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Spitfire H.F. VII.

**Hide Glue.** A glue which is obtained from the hides, hoofs, or bones of animals. It is boiled down and sets to a gelatine substance, and when required for use it is re-soaked, boiled, and applied warm. Its adhesive strength varies. It is very occasionally used in aircraft structures.

**High.** A term used in meteorology to indicate an anticyclone.

**High Altitude Bombing.** The term used to denote that the bombs were released at a height of over 10,000 ft.

**High Clouds.** Clouds with a mean height above 25,000 ft. They are composed of ice crystals.

See also CIRRUS; CIRRO-CUMULUS; CIRRO-STRATUS.

**High Fog.** Fog in a layer above the surface of the ground in which ground visibility is relatively unaffected. Such a fog may produce intense darkness. It is due to condensation and/or accumulation of smoke.

**High Pressure Area.** A region of relatively high barometric pressure. This atmospheric condition usually results in clear and good weather.

See also ANTICYCLONE.

**High Pressure Oxygen.** A system in which oxygen is supplied in containers or bottles under pressure for respiration purposes at high altitudes.

**High Tension.** Electrical systems working above 300 volts D.C. and 150 volts A.C.

**High Tension Battery.** A bank of accumulators for providing high tension voltage.

**High-speed Steel.** A series of steel alloys which contain tungsten and, in addition, molybdenum and cobalt. They retain their strength



when red hot, and their chief use is for metal-cutting tools.

**High-wing Monoplane.** A monoplane in which the wing is located at the top or over the fuselage.

See also PARASOL MONOPLANE.

**Hill's Mirror.** An instrument for determining the direction of motion of a cloud. It indicates the angular velocity by the point of the earth's surface which is vertically below it.

**Hinge Moment.** The moment due to aerodynamic forces about the hinge axis of an aerofoil.

**Hoar-frost.** A white crystalline deposit which forms on grass and other objects by condensation of water vapour from the air when the temperature of the objects is below freezing point.

**Hogging.** The tendency of a hull to drop at stem and stern when those points are unsupported. It is due to lack of longitudinal stiffness.

**Homing.** When used in relation to the flight of an aeroplane this means that the aeroplane is being flown by the use of wireless facilities, and is being directed towards its destination.

**Homing Mechanism.** May be either a fixed loop or a rotating loop that can be tuned on the desired transmitting station.

**Honeycomb.** A grid of intersecting surfaces used in a wind tunnel to cause true lineal airflow. It also refers to a type of radiator used for liquid-cooled engines.

**Honeycomb Radiator.** A liquid cooling system which consists of a block of air tubes surrounded by a liquid.

**Honing.** A process which polishes the surface of cylinder bores after the final machining operation. The spring-loaded grinding stones are so arranged that they reciprocate at the same time as they are rotated.

**Hooke's Law.** This law states that within the elastic limit of the

material the strain is proportional to the stress producing it.

**Hop.** A colloquial term which refers to a flight of short duration, usually carried out at low altitudes.

**Horizon.** The line where the earth and sky apparently meet as viewed from any given point.

**Horizontally Opposed Engine.** An engine in which the cylinders are placed horizontally and on opposite sides of the crankcase.

**Horn Balance.** An extension attached to a control surface of an aircraft. The balance is confined to the tip of the control surface and extends beyond the hinge line. The horn or surface in front of the hinge assists the pilot in moving the control surface.

**Horse Latitudes.** The belts of calms, light winds, and fine clear weather. These winds are prevalent at approximately 30° north and south of the Equator. They are between the prevailing westerly winds of high latitudes and the trade wind belts.

**Horse-power.** The unit of power. One horse-power is the amount of energy expended in raising 33,000 lb. through a distance of one foot in one minute, or 550 foot-pounds per second. In electrical work, one horse-power equals 0.746 kilowatt or 746 watts.

The metric horse-power is equal to 75 kilogram-metres per second.

**Hover.** A term which refers to an aeroplane which is flying near its stalling speed against a head wind and appears to be suspended in one spot above the earth.

**H.P.** See HORSE-POWER.

**H.T.** See HIGH TENSION.

**Hucks Starter.** A device which is used for starting aero engines. It consists of a claw which grips the nosepiece of the propeller and is rotated by the engine of the starter.

**Hull.** The main structure of a flying boat or boat amphibian

which gives the necessary buoyancy when on the water. In aerostats it is the structural framework of a rigid airship.

**Humidity.** The degree to which the air is charged with water vapour. The amount of water contained in a given sample of air.

See also ABSOLUTE HUMIDITY; RELATIVE HUMIDITY.

**Hump Speed.** The speed of a seaplane or amphibian in the water during take-off at which the water resistance reaches a maximum.

**Hunt or Hunting.** An engine is said to hunt when its speed rhythmically varies above and below a steady average.

Similarly, an aeroplane is said to hunt when its longitudinal axis pitches up and down rhythmically about a mean position. This is due to dynamic instability.

See also PHUGOID OSCILLATION.

**Hurricane.** See TROPICAL REVOLVING STORM.

**Hurricane Wind.** A wind of force "12" on the Beaufort scale. It is seldom experienced, except in tornadoes or tropical storms.

**Hydraulic Press.** A press which is operated by water or oil pressure. Large hydraulic presses are used for forming sheet metal parts for aircraft. The work is done by using male and female dies.

**Hydrocarbons.** Combinations of hydrogen and carbon which exist in many forms. Hydrocarbons occur in large quantities in coal and petroleum.

**Hydrogen.** A chemical element, symbol H, which is odourless, colourless, and tasteless. It is a highly inflammable gas and is the lightest substance known. Used for the inflation of aerostats. The oxide of hydrogen is  $H_2O$ , or water.

**Hydrogenated Oils.** Vegetable or fish oils which, in the presence of a catalyst, have been solidified by the action of hydrogen.

**Hydrogenization.** Combining cracked fuel with hydrogen to produce a high anti-knock stable fuel. A suitable catalyst must be employed.

**Hydrometer.** A glass incorporating a floating bulb and scale employed to compare the densities of liquids. There are two types: the specific gravity hydrometer and the thermo-hydrometer.

**Hydroplane.** A flat-bottomed marine craft which is incapable of flight, but skims over the water.

Hydroplaning is a term used to indicate the second stage of the take-off of a seaplane, i.e. when the seaplane is only partially air-borne.

**Hydrosphere.** This refers to the parts of the earth which are composed of water.

**Hydrovane.** A planing surface which was occasionally fitted to landplanes to assist alighting on water in an emergency, a device which has now been abandoned.

**Hydulignum.** This is a laminated board used for the manufacture of propellers. It is of birch veneers using a thermoplastic adhesive. After first compression in the plane of the veneers the specific gravity is 0.9. The boards so formed are then re-heated in another press whilst the existing compression is maintained. Then side pressure is applied which brings the density of the board to a specific gravity of approximately 1.3. Another advantage of the side-pressing is that it creates corrugations in the veneers which are a contributory factor to the very high shear figures obtained with this material.

**Hyetograph.** A rain gauge which is self-recording.

**Hygograph.** A hygrometer which is self-recording.

**Hygrometer.** An instrument designed to measure the amount of humidity of the atmosphere.

**Hygrometry.** A science dealing

with the moisture content of the atmosphere.

**Hygro-thermograph.** An instru-

ment which makes graphical recordings of the humidity and temperature of the atmosphere.

## I

**I.C.E.** See INTERNAL COMBUSTION ENGINE.

**Ice Accretion.** Under certain weather conditions ice may form on the wings and other parts of aircraft. When the rate of formation is slow the ice is mostly of a crystalline nature and forms mainly on the leading edges. When the deposition is rapid, clear ice forms and adheres firmly to all the surfaces.

**Ice Fog.** A type of fog which occurs in polar regions and high altitudes. It consists of small ice crystals. Vertical visibility is not affected, but horizontally it is poor.

**Iceberg.** A large mass of floating ice which has broken away from a glacier or ice sheet.

**"Ice-up."** The term which is used to indicate that ice has formed in the carburettor or on the leading edge of the wings, etc., of an aeroplane.

**Identification Lamp.** A lamp mounted on an aircraft for purposes of recognition.

**Identification Light.** A light easily identified which is carried on the rear part of an aeroplane for identification at night.

It also refers to a light near a beacon which is illuminated in a special way in order to identify it.

**Idle.** To run an internal combustion engine at low revolutions per minute under no load.

**Ignition Cables.** Cables provided for carrying the current from the magneto to the plugs of an internal combustion engine.

See also SCREENED IGNITION CABLES.

**Illuminated Wind Cone.** See ILLUMINATED WIND INDICATOR.

**Illuminated Wind Indicator.** An illuminated device which indicates the direction of the surface wind.

It may be in the form of a T or a cone.

**Illuminated Wind T.** See ILLUMINATED WIND INDICATOR.

**Immelmann Turn.** An aerobatic manoeuvre credited during the war 1914-18 to the German airman of that name. Its value is due to the fact that a pilot can reverse completely and quickly the direction of flight and gain altitude at the same time. The aeroplane is dived, then pulled up into the first half of a loop, change in direction being obtained at the top of the loop. The aeroplane is then half-rolled about its longitudinal axis and normal flight is continued.

**Impact Test.** The test of a specimen of metal which measures the toughness and the resistance characteristics of the metal. The test specimen is hit by a weight attached to a pendulum which is allowed to swing through a known arc, or a weight is dropped from a predetermined height.

See also IZOD TEST.

**Impulse.** A sudden acceleration. It is the force required to give momentum to a mass.

**Incendiary Bomb.** A type of bomb designed to set fire to an objective on impact. It may or may not have an explosive charge.

**Incendiary Bullet.** An incendiary bullet is one whose contents, on being exposed to the air, begin to burn. It burns during its passage through the air and on striking inflammable material sets it alight.

The filling is known as incendiary compound, which has a foundation of phosphorus.

**Incidence, Angle of.** See ANGLE OF INCIDENCE.

**Incidence Indicator.** An instrument which indicates the angle in

the plane of symmetry between the longitudinal axis and the flight path of an aircraft.

**Incidence Wires.** Wires bracing the main planes between the fore and aft struts of a biplane.

**Inclination of the Wind.** The angle which the direction of the wind makes with the direction of the isobar at any particular point. The angle is usually between 20 and 30 degrees.

**Inclinometer.** An instrument for indicating the attitude of an aircraft to the earth's surface.

**Inconel.** The trade name which refers to a nickel-chromium-iron alloy. Inconel contains approximately 80 per cent nickel, 14 per cent chromium, and 6 per cent iron. Its physical properties are similar to those of stainless steel. This material cannot be hardened by heat-treatment. Annealing will, however, relieve the effects of cold-working.

**Indian Air Force.** This Force was formed in October, 1932, and the first squadron was authorized in April, 1933.

**Indicated Air Speed.** The air speed as indicated by an air speed indicator. This is consistent only until the effect of compressibility at the pressure head becomes noticeable.

**Indicated Altitude.** The altitude of an aircraft as indicated by the altimeter.

**Indicated Horse-power.** The total of the horse-powers developed in all the cylinders of an internal combustion engine.

**Indicator Diagram.** A graphical representation of the variations of pressure which occur inside the cylinder of an engine. It is obtained by means of an instrument termed an indicator.

**Induced Current.** A current caused to flow in a closed circuit by the influence of a varying magnetic field. A momentary current is induced in a closed circuit—

(i) When a magnet is moved about in its vicinity, or vice versa.

(ii) When a current is switched on in an adjacent circuit.

(iii) When a current is switched off in an adjacent circuit.

(iv) When a circuit carrying a current is moved about in its vicinity, or vice versa.

**Induced Drag.** That part of the drag which is caused by the lift obtained by an aerofoil. If the air had no viscosity, the induced drag would be the total resistance which would be met.

**Induction Flame Damper.** A device fitted to prevent the escape of flame in the event of a back-fire or blow-back from the engine. It is fitted in the induction system.

**Induction Manifold.** A system distributing the combustible mixture to a number of cylinders of an engine by a common pipe.

**Induction Pipe.** A pipe for supplying the combustible mixture to one cylinder only of an engine.

**Induction Pressure Gauge.** An instrument which indicates the actual pressure in the induction pipe of a supercharged engine.

See also BOOST GAUGE.

**Induction System.** The complete system of piping, manifolds, carburettor, air scoops, accessories, etc., which is used to supply the engine with a fuel/air mixture.

**Inertia.** This is defined by Newton's first law of motion as that property of matter because of which a body at rest tends to stay at rest and a body in motion tends to continue in motion, unless acted upon by some external force. The centre of inertia of a body is the same as its centre of gravity.

**Inertia Starter.** A device utilizing the stored-up energy (inertia) in a small spinning flywheel for starting an engine. The flywheel is energized by means of a hand crank or an electric motor and the flywheel is

connected to the engine through a clutch.

See also **HAND INERTIA STARTER**.

**Inflation.** The act of filling a balloon or the envelope of an airship with gas. It is sometimes called gassing.

**Inflation Net.** A net made of cord or rope which is used to hold down the envelope of an aerostat whilst it is being inflated.

**Inflow.** The increase in air velocity in front of a propeller which is caused by its rotation.

**Inherent Instability.** The term used to indicate the opposite of inherent stability (q.v.).

**Inherent Stability.** Stability which is solely due to the position and arrangement of the fixed parts of an aircraft, i.e. that property which, when disturbed, causes an aircraft to return to its normal attitude of flight without the use of controls by the pilot.

**In-line Engine.** An internal combustion engine which has all its cylinders in one or more rows and arranged from front to rear.

**Inner Marker Beacon.** A beacon which emits in a vertical direction a radio signal with special characteristics, and which is situated about one mile from the main beacon and in the line of approach in the standard beam approach system.

**Inspection Port.** A small transparent port fitted in the fabric-covered portions of an aeroplane or in an aerostat, to permit the inspection of the interior. Sometimes called an inspection window.

**Instability.** This term refers to any disturbance of steady motion of an aircraft which tends to increase. An aircraft in steady motion if unstable will not return to its original state of motion if it has been disturbed without the movement of the controls by the pilot.

See also **ROLLING INSTABILITY**; **WEATHER COCK INSTABILITY**.

**Institution of Aeronautical Engineers.** This Institution was amalgamated with the Royal Aeronautical Society in October, 1927.

**Instructors' Certificates.** Instruction in flying in the British Isles may be given only by holders of pilots' licences. These certificates are authorized by the Air Ministry. The certificates may be held by either Class A or B pilots who pass the instructors' examination of the Guild of Air Pilots and Navigators of the British Empire. Candidates may be of either sex and must—

(i) Produce proof of at least 250 hours' flying experience.

(ii) Have been suitably coached as an instructor.

(iii) Pass an oral technical examination and a practical flying test.

The cost of the Guild of Air Pilots and Navigators Certificate, including the examination, is £3 3s. The certificates are valid for one year and are renewable on evidence of at least 50 hours' instructional flying during the preceding year.

**Instrument Flying.** The art of operating an aircraft by the sole use of instruments, the pilot having no outside visual aid. Colloquially known as "blind flying."

**Instrument Landing.** A landing which is made without external visual aid. The required information is obtained by the pilot by the use of instruments and the help of ground radio devices.

**Intercardinal.** North-east, south-east, south-west, north-west. They are the same as quadrantal points of a compass.

**Interception.** The method of making contact at the earliest possible moment with another aeroplane or a vessel at sea.

**Interceptor.** A device which consists of a small plate which is situated on the upper surface of a wing just behind the wing slot to spoil the effect of the slot at high

angles of attack. It is actuated by and assists the lateral control.

**Intercooler.** A device fitted on the delivery side of a supercharger in order to cool either (a) the compressed air, or (b) the combustible mixture.

**Intercostal.** Members which run in series longitudinally between the frames of a hull or float.

**Intercostal System.** Indicating the principle on which a hull or float is constructed.

**Interference.** The influence of two or more bodies on one another due to the disturbance of the airflow over the bodies.

See also INTERPLANE INTERFERENCE.

**Interference Drag.** This drag is due to the interference of the airflow around two parts of an aeroplane which are near to each other.

**Intermediate Longitudinal.** An auxiliary longitudinal of light weight between two main longitudinals of an aerostat.

**Intermediate Radial Strut.** In an aerostat this is the strut which connects the inner and outer ridge intermediate joints of the stiff-jointed main transverse frame.

**Intermediate Transverse Frame.** In an aerostat this is the system of members which connects the longitudinal girders and which forms a complete ring between the main transverse frames.

**Intermittent Light.** A light which has bright and dark periods when seen from a fixed point.

**Intermittent Weld.** A weld which is not continuous from the beginning to the end. There are alternate spaces of weld and no weld.

**Internal Combustion Engine.** An engine which derives its power from the combustion of a fuel inside a closed cylinder, as opposed to the type in which the fuel is burnt outside as in the boiler of a steam engine.

See also OTTO CYCLE; DIESEL ENGINE; FOUR CYCLE ENGINE.

**Internal Strap.** A strip of metal attached to the inner profile of adjacent frames of a hull or float, so tying the two frames together.

**Internal Supercharger.** A type of supercharger in which the impeller is situated in the induction system between the carburettor and the internal combustion engine cylinders.

**International Standard Atmosphere.** An imaginary atmosphere which is used when comparing the performance of aircraft. It assumes that at mean sea level there is a temperature of  $15^{\circ}\text{C}$ . and a pressure of 1013.2 millibars accompanied by a lapse rate of  $6.5^{\circ}\text{C}$ . per 1000 metres from sea level up to 11,000 metres. Above this height the temperature is assumed to be constant at minus  $56.5^{\circ}\text{C}$ .

**Interplane Interference.** If two aerofoils are placed one above the other, then the region of high pressure below the top aerofoil will be in close proximity to the region of low pressure above the bottom aerofoil. These two different pressures tend to neutralize each other. The decrease in pressure above the top aerofoil remains practically unaffected, but the increase in pressure below this aerofoil is partially destroyed by the presence of the lower aerofoil. The top aerofoil will, therefore, lose some of its lift.

A similar action takes place as regards the pressures of the lower aerofoil, but the bottom surface remains unaffected. The decrease of pressure on the top surface will be reduced by the presence of the upper aerofoil.

**Interplane Struts.** The vertical members between the upper and lower wings of a biplane or multiplane.

**Interpolation.** This refers to the method of using known figures or values to estimate the probable

figures or values which lie between these known quantities.

**Interruptor Gear.** A mechanism which interrupts the action of a gun and prevents it firing when the propeller blade is in the line of fire.

**Invar.** A nickel-iron alloy which has a very low thermal expansion and is very resistant to corrosion by water. Owing to its low coefficient of expansion it is used in the manufacture of measuring instruments.

**Inversion.** A term used in meteorology to denote the inversion of the vertical gradient of temperature. When the temperature increases with height through a given layer of air in place of the normal decrease there is said to be an "inversion."

**Inversion Point.** In meteorology this is the height or point at which the inversion of the temperature gradient ceases and the normal decrease of temperature with height begins.

**Inverted Engine.** An internal combustion engine which has its cylinders below the crankshaft.

**Inverted Flight.** Flying an aeroplane in an upside down position.

**Inverted Loop.** A complete revolution of an aeroplane about its lateral axis, in which the upper surface of the wings is on the outside of the curved flight path.

**Inverted Spin.** An abnormal spin in which the mean angle of incidence is negative.

**Inwales.** A term used in hull construction. It denotes the longitudinal members at the junction of the top-sides and deck.

**Iraqi Air Force.** This Air Force was formed in 1931, all the personnel being Iraqi.

**Iron.** One of the chemical elements, symbol Fe. It is the principal constituent of steel and its alloys. In its pure state it is silver or greyish white. Specific gravity 7.86.

**Isallobars.** Lines which are drawn on a map showing equal changes of

barometric pressure in a given period of time. These isallobars are formed by plotting the changes in barometric pressure which have taken place between two sets of observations.

**Isobar.** A line on a meteorological or weather chart drawn through places or points which have the same barometric pressure.

**Isoclinic Lines.** Lines which are drawn on a map or chart and which connect points of equal magnetic dip.

**Isogonic Lines.** Lines drawn on a map or chart which join positions which have equal magnetic variation.

**Iso-heptane.** A member of the paraffin series which has the same general formula as heptane ( $C_7H_{16}$ ) but differs in the relative location of the carbon atoms. It is a fuel which is liable to detonation and is therefore given an octane rating of nil.

See also OCTANE NUMBER.

**Iso-octane.** A member of the paraffin series of fuels which has the same general formula as octane ( $C_8H_{18}$ ) but differs in the relative location of its carbon atoms. It is used as the theoretically perfect anti-knock fuel, and is given an octane rating of 100.

See also OCTANE NUMBER.

**Isotherm.** A line which connects points of equal temperature on a meteorological or weather map. The lines are usually shown in divisions of  $10^\circ F$ .

**Isothermal.** This means of equal temperature. The term is applied to any layer of the atmosphere in which there is no appreciable alteration of temperature with height. The stratosphere was at one time referred to as the isothermal layer.

**Izod Test.** This impact test is made on a notched bar, and the method of testing is standard for British aircraft steels. It is sometimes referred to as the notched bar or impact test.



## J

**Jack Stay.** A wire which maintains the accurate spacing between component parts of a rigging system in an aerostat.

**Japanning.** This is a term which refers to the application of enamel either for protective or decorative purposes.

**Jet Propulsion.** A system of aircraft propulsion by means of a fluid jet or jets in accordance with Newton's Laws of Motion. The jet may be produced in several ways, but is most generally formed by taking in air through a suitably shaped duct at the front of the aircraft, compressing it, heating the compressed air by the burning of a fuel and then expanding the resultant gases in a jet pipe to form a high-velocity jet.

See also **ROCKET PROPULSION**.

**Jettison Gear.** A fitting for the rapid discharge of fuel from an aircraft in an emergency whilst in the air.

**Jig.** A rigid structure which may be manufactured in either wood or metal. It holds parts while they are being manufactured or holds the component parts of a structure while it is being assembled.

**Joggle.** The bending of a small portion of a sheet of metal so that one part will clear other parts.

**Johansson Gauge Blocks.** These are precision instruments which are mechanically and metallurgically the most perfect steel blocks known. They are used when exceptionally accurate measurements are required.

**Johnstone Memorial Air Navigation Trophy.** This is a silver plaque

showing Mercator's projection of the world, surmounted by an engraving of the late Squadron Leader E. L. Johnstone, O.B.E., A.F.C., who was lost in the R.101 disaster in 1930. The prize is awarded annually for what is considered by the Guild of Air Pilots to be the best feat of air navigation.

**Joint Aviation Advisory Committee.** An organization composed of Lloyd's Register and the British Corporation, to register all aircraft. It is authorized by the British Air Ministry to inspect and recommend for renewal certificates of airworthiness for aircraft.

**Joule.** A unit of work or energy equal to 10,000,000 ergs. It is the amount of energy expended in one second by an electric current of one ampere against a resistance of one ohm.

**Joule's Law.** This law states: The amount of heat generated in an electrical circuit is proportional to the square of the current and is also proportional to the resistance of the circuit and the time during which the current flows.

**Joy Stick.** A slang term for control column (q.v.).

**Junction Piece.** A special fitting which secures the main cable to the lower ends of the metallic vee of a kite or captive balloon.

**Jury Strut.** A strut used during repairs or on special occasions to provide temporary support for a structure.

**Jute.** A tough fibre for making ropes and certain types of fabric.

## K

**Kapok.** This is a fibre of a silky nature obtained from the covering of the seeds of a tropical evergreen tree. It is used as a filler for the cushions fitted to aircraft and for the purpose of insulating heat and sound.

**Katabatic Wind.** A local wind due to convection and caused by the down-wind motion of the cold air from high ground.

**Kaus.** A south-easterly or easterly wind which occurs in the Persian Gulf. The Kaus heralds the approach of a winter depression. Wet and cloudy weather, which may last over a prolonged period, is associated with this, and is generally followed by squally Shamals.

**Keel.** A closing-in plate or shaped piece on the bottom centre line of the boat to which the frames and the sides are anchored. It is the lowest main longitudinal member of a hull or float and forms a means of supporting the loads from the transverse frames.

**Keel Angle.** This is the angle which is formed by straight lines joining the central keel and the chines in the cross-section of a hull or float.

**Keel (Vertical).** A keel which is so constructed that its major axis in cross-section is in the vertical plane, the most common form of keel in hull and float construction. It is sometimes referred to as a centre keelson.

**Keelson.** An inner vertical longitudinal member on the centre line of a hull or float and situated above the keel.

**Khamsin.** A hot, dry, southerly wind which blows over Egypt in front of depressions passing eastward along the Mediterranean. It

occurs mainly in March, April, and May. It is similar to a Sirocco.

**Kharif.** This is an intermittent but severe dust storm. It occurs during the period from May to September in Somaliland.

**Kiln-dried.** Wood artificially seasoned by being placed in a drying oven or "kiln."

**Kilo.** A prefix which means 1000 in the metric system of measurements.

**Kilogram.** A unit of weight. 1000 grams or 2.204 lb.

**Kilowatt.** The practical unit of electrical power. 1 Kilowatt = 1000 watts = 1.34 h.p.

**Kinetic Energy.** This term indicates the capacity of a moving body to perform work.

**King Post.** A vertical compression member which supports a main braced member which is subject to bending stress. It has many uses in aircraft construction.

**Kite.** An aerodyne which obtains its lift by non-mechanical means and depends upon its angle of attack to the airflow, which is obtained by anchoring or being towed by a line.

**Kite Balloon.** A captive balloon, fitted with lobes to keep it headed into the wind, and shaped to derive stability from the relative wind. It is an elongated type of the normal spherical balloon.

**Knot.** A nautical mile per hour, that is, a speed of 6080 ft. per hour. It is a unit of speed and should not be used as a measure of distance.

**Krupp Krankheit.** See TEMPER BRITTLENESS.

**Kuk.** A unit of measurement which defines air density in terms of mass, expressed as "kuks" per cubic metre. A kuk is equal to 9.81 grams.

See also SLUG.

## L

**L.A.C.** See **LEADING AIRCRAFT-MAN.**

**Lacquer.** A finishing material made from nitro-cellulose, cellulose acetate resins, or other synthetic resins.

**Lag.** The inability of a mechanical or electrical mechanism to accommodate itself to rapid changes. It is sometimes expressed as the time element in the operation of the instrument.

**Laminar Flow.** A particular type of streamline flow. It normally refers to the flow of a viscous fluid near solid bodies when the flow is not turbulent.

**Laminated Wood.** A structure which is formed by gluing or fastening together a number of layers of wood with the grains parallel, in contradistinction to plywood, in which the grains of alternate plies are crossed at approximately right angles.

**Land and Sea Breezes.** The breezes which occur on certain coasts and in certain atmospheric conditions and blow from the land by night and from the sea by day.

See also **LAND BREEZE**; **SEA BREEZE.**

**Land Breeze.** An off-shore wind caused by the more rapid cooling of the air over land than over the sea. It occurs on clear nights.

**Landing.** The term used to denote the alighting of an aircraft on land or water. The manoeuvre consists of placing the aircraft in a normal glide until it approaches within a few feet of the ground and gradually levelling off until it is within two or three feet of the ground. In this position the aircraft is held in level flight. As speed is decreased the control column is

pulled gradually back until the aircraft stalls and settles on to the land or water. The control column is not moved again until the aircraft is at a standstill.

See also **ALIGHTING.**

**Landing Angle.** When an aeroplane is resting on level ground in its natural position. This is the angle between the line of thrust of the aeroplane and the horizontal.

**Landing Area.** That section of an airfield or airship station which is specially prepared for taking off and landing.

**Landing Area Floodlight.** A method of illuminating all or a large part of the surface of a landing area of an airfield.

**Landing Direction Light.** A light or a number of lights designed to indicate the direction in which landings on airfields are to be made during darkness.

**Landing Gear.** The structure which supports the weight of an aircraft when in contact with the land or water. It embodies a shock-absorbing device for landing. It includes landing wheels, tail wheel or skid. Also known as an under-carriage.

**Landing Ground.** A piece of ground which has been specially prepared so that aircraft may land. Generally there are no servicing facilities, but shelters may be available.

**Landing Lamp.** A lamp fitted on an aircraft and operated by the pilot to illuminate the earth's surface when landing. Sometimes called a landing light.

**Landing Run.** The distance travelled by an aircraft in contact with the earth's surface during landing.

**Landing Speed.** The minimum safe speed of an aeroplane at the

instant of contact with the land or water in a normal landing.

**Landing T.** A structure shaped like a capital T. This is laid out on a landing ground or on the top of a building to guide pilots when landing and taking off.

**Landing Wire.** A wire or cable which braces the aeroplane wing structure and resists the forces which oppose the lift. Also called an anti-lift wire. A landing wire runs outward and downward from the fuselage.

**Landmark Beacon.** A beacon for indicating the position of a landmark. This term does not refer to beacons specially erected on airfields or on airway routes.

**Landplane.** An aeroplane with an undercarriage specially designed to rise from and alight on the land.

**Lap Joint.** A joint in which the two edges of the sheet metal overlap each other. Held together by rivets, bolts, welding, etc.

**Laps.** This is a term used to denote a defect in steel which usually appears on the surface of the metal. It is sometimes due to molten metal splashing on the sides of the ingot mould when pouring. It then oxidizes and is subsequently covered by the rising fluid. This metal becomes elongated when passing through the rolls. During subsequent heat-treatment these laps may develop into cracks.

**Lapse Rate.** The rate of decrease of temperature in the atmosphere with increased height.

**Lateral Axis.** A hypothetical line which is at right angles to the longitudinal axis, passes through the centre of gravity of the aeroplane, and lies within a plane normal to the plane of symmetry. Angular movement about this axis is called pitching.

**Lateral Clinometer.** See CROSS-LEVEL.

**Lateral Divergence.** The insta-

bility of motion which leads to a spin with increased rate of turn. It is any non-periodic combination of side-slipping, yawing, and rolling.

**Lateral Force.** The component along the lateral axis of the resultant force. It includes the resolved component of gravity. If the resolved component of gravity is neglected it is better to refer to "lateral air force."

**Lateral Oscillation.** The motion of an aircraft which is made up of periodic variation of yawing, rolling, and side-slipping.

**Lateral Stability.** Stability with reference to the motions about the longitudinal axis of an aircraft, i.e. disturbances involving rolling, yawing, or side-slipping. It is the ability of an aeroplane to remain in level flight, or return to normal flight when once disturbed, without the use of the controls by the pilot.

**Lateral Velocity.** The component velocity in relation to the air measured along the lateral axis.

**Latitude.** Angular distance of a point on the surface of the earth north or south of the Equator. It is measured up to 90 degrees north or south of the Equator, in degrees, minutes, and seconds. A distance of latitude of 1 degree averages 69.17 miles.

**Lay Off.** A technical term which is used in hull and float construction. It refers to the marking off of the design from the scale drawings to the full size on the mould loft floor.

**Lead.** A chemical element, symbol Pb. It is mixed with copper in lead-bronzes which are used for bearings. Lead and copper do not alloy, but the lead is held in solid suspension.

**Lead Accumulator.** An accumulator with both plates made of lead.

**Leading Aircraftman.** The highest technical qualification of an aircraftman in the Royal Air Force.

It signifies the highest skill of hand in his trade.

**Leading Aircraftwoman.** A classification in the W.A.A.F. similar to Leading Aircraftman in the R.A.F.

**Leading Edge.** The front edge of an aerofoil or propeller blade.

**Leading Edge Radiator.** A cooler which forms the leading edge of the main plane of an aeroplane.

**Leading Stone.** See **LODESTONE**.

**Leak Detector.** An instrument for detecting the presence of hydrogen in the air. It is used to find leaks in an envelope of an aerostat.

**Leakage.** In an aerostat it is the term used to denote the loss of gas from an envelope arising from effusion, diffusion, or escape into the air through the neck of the balloon.

**Leeward.** Away from the wind.

**Leeway.** This means the correction which must be made to allow for the effect of cross-winds during the flight of an aircraft.

**Left-hand Engine.** An engine whose propeller shaft rotates in a counter-clockwise direction to an observer looking at the propeller from the engine end of the shaft.

**Left-hand Magneto.** A magneto revolving counter-clockwise as seen by an observer at the driving end.

**Left-hand Propeller.** A propeller which revolves in a counter-clockwise direction as viewed by an observer standing at the rear of the aircraft.

**Lenz's Law.** A law of electricity which states that the direction of an induced current is opposite to the direction of the current which produces it.

**Leste.** A hot, dry, southerly wind in Madeira and Northern Africa. It precedes an advancing depression.

**Levanter.** An easterly wind which occurs in the Straits of Gibraltar. If the wind is of moderate force a cloud appears over the Rock of

Gibraltar. The formation of this cloud is known as the Levant.

**Leveche.** A hot, dry, south-west wind which occurs in Spain. It precedes an advancing depression.

**Level Bombing.** This refers to bombing whilst the aeroplane is in level flight.

**Levers.** See **AILERON LEVER**; **ELEVATOR LEVER**; **RUDDER LEVER**.

**L.F.** Letters used to denote low altitude fighter. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Spitfire L.F.VB.

**L Head Cylinder.** A type of cylinder which has all its valves on the same side.

**Life Line.** When the rigging lines and the harness of a parachute are not directly connected, the cable between them is known as the life line. This line is essential with attached parachutes or parachutes having single point connexions to the harness.

**Lift.** The difference between the density of the air and the gas contained in the envelope of an aerostat. In aerodynes it is the component along the lift axis of the resultant force produced by the relative wind. It is perpendicular to the flight path in the plane of symmetry.

**Lift Axis.** This term applies only to aerodynes. It is the straight line passing through the centre of gravity, and is in the plane of symmetry and perpendicular to the relative airflow. The positive direction is upwards in normal level flight.

**Lift Drag Ratio.** The ratio of the lift to the drag of any body, particularly an aerofoil. It is a measure of the aerodynamic efficiency of the aerofoil.

**Lift Off.** A parachute descent which is commenced by the release of the canopy of a parachute before the user leaves the aircraft. The

pressure of the air in the canopy pulls the individual off the aeroplane. It is sometimes called a "pull off."

**Lift Wires.** In aerodynes the lift wires or cables for transferring the lift obtained from the wings to other parts of the aerodyne. They are more usually called flying wires. In an aerostat they are the wires in the plane of the transverse frame which transmit the loads due to gravity to the upper part of the hull.

**Light Aeroplane.** An aeroplane having an all-up weight of less than 1000 lb. and a wing loading which must not exceed 6 lb. per sq. ft.

**Lightening Holes.** Holes machined in aircraft parts. The metal has been removed because in that particular location it was not doing useful work. Its removal reduces the weight without decreasing the strength. Holes of this kind are generally flanged, i.e. the edges are turned up at right angles for stiffening purposes.

**Lighter-than-air Aircraft.** An aircraft whose lift is derived from the buoyancy of the surrounding air, as in aerostats.

**Lightning.** An electrical discharge in the atmosphere.

**Limit of Proportionality.** This refers to the elastic limit of a metal and is the point on a stress-strain curve where strain ceases to be proportional to stress.

**Limiting Velocity.** The maximum velocity which can be attained by an aircraft at any defined angle to the horizontal. This velocity must be measured under given atmospheric conditions and a specified state of operation of the engine and propeller. The highest value is known as the terminal velocity.

**Limits.** The maximum and minimum permissible dimensions of a part. Limits are applied for the following reasons: (1) To obtain

certain specified fits between parts for the proper working of the mechanism; (2) to enable parts to be made at different manufacturers and still operate correctly when assembled; (3) to maintain interchangeability in order that assembly and repair can be undertaken with the least possible delay and expense; (4) to indicate to the mechanic the accuracy which is necessary.

**Linear Velocities.** See AIR SPEED; LATERAL VELOCITY; LIMITING VELOCITY; LONGITUDINAL VELOCITY; NORMAL VELOCITY.

**Linen Fabric.** A linen manufactured from unbleached flax fibre. It is used as a covering on wings, control surfaces, and fuselages.

**Line Squall.** A series of squalls occurring simultaneously and marking the position of a cold front advancing across a country, occasionally accompanied by a brief gust of wind. It normally occurs with the passing of a trough. When this passes, the wind shifts rapidly with a violent gust, and this is followed by a rapid fall in temperature, with showers of hail or snow and often thunder and lightning.

**Line Vortex.** A vortex in which the fluid forms a long tube and is of small cross-section.

**Link Trainer.** A ground trainer used by flying training schools to simulate actual flying conditions. It is a mechanical device comprising a small fuselage and wings, mounted on a turntable operated by bellows. The instructor can control all flight conditions. Link trainers are equipped with blind flying instruments and two-way wireless communication. The instructor is not in the link trainer, but is in communication with the pupil by wireless.

**Linseed Oil.** An oil extracted from flax seed which is used for thinning lead paints.

**Liquid Coolants.** The liquid or a

mixture of liquids which is used for cooling an internal combustion engine. Ethylene glycol and water is the liquid coolant generally used for aircraft engines.

**Liquid Oxygen.** Oxygen reduced to liquid form by cold and pressure. It is a transparent, blue liquid, and is used for respiration purposes at high altitudes. Oxygen liquefies at  $-113^{\circ}\text{C}$ . at a pressure of 59 atmospheres.

**Litharge.** Yellow lead monoxide which is used as a pigment. Chemical formula,  $\text{PbO}$ . When mixed with glycerine it is valuable for preventing leaks in permanent connexions.

**Litre.** A unit of volume. It is equal to 61.02 cub. in.

**Lizard.** A short length of rope or cable, with an eye at the outer end.

**Load Factor.** The ratio of the failing load of a member to the assumed load under a specific condition of flight. The term "factor of safety" as used in general engineering practice must not be confused with this term.

**Load Ring.** A ring to which the net of a free balloon is secured in addition to the suspensions for the basket.

**Load Water Line.** The line marked on a boat or hull to indicate the maximum depth to which the boat or hull may be submerged under load.

**Loading Handle.** A device which is fitted to a gun for loading, unloading, or clearing a jam.

**Loadings.** See POWER LOADING; SERVICE LOAD; WING LOADING; PAY LOAD.

**Local Magnetic Attraction.** The term used to indicate the presence of large masses of iron in some localities which produce a deviation of the earth's magnetic lines of force. When flying takes place near that location the compass needle is subjected to variation.

**Locking Ring.** See WIRE LOCKING RING.

**Locking Wire.** A flexible wire sometimes used to prevent the turning of nuts, bolts, and turn-buckle barrels.

**Lodestone.** Chemical formula,  $\text{Fe}_3\text{O}_4$ . A magnetic stone, discovered by the Chinese during the early days of civilization. It is mainly composed of oxide of iron which acts like a magnetic needle. Its magnetic properties led to the development of the compass.

**Log Books.** Every aircraft must be provided with an aircraft log book and an engine log book for each engine. All such log books must be preserved for two years after the last entry.

**Logarithm.** The logarithm of a number is the power to which another number, called the base, must be raised to equal the number, e.g.  $10^3 = 100$ , and therefore the logarithm of 100 to the base 10 is 2. This can also be written  $\log_{10} 100 = 2$ . 10 is the base commonly used. Conversely, the antilogarithm of 2 is 100.

**Longeron.** A main longitudinal member of the structure of an aeroplane fuselage or nacelle.

**Longitude.** The distance measured along any parallel of latitude from the zero meridian to the meridian running through that particular place. It is measured in degrees, minutes, and seconds up to  $180^{\circ}$  east or west of the zero meridian.

**Longitudinal.** A girder which runs fore and aft on the outside of the hull of an aerostat.

**Longitudinal Axis.** A longitudinal datum line through the middle of the fuselage, the centre of gravity of the aeroplane in the plane of symmetry. Movement about the axis is called rolling.

**Longitudinal Bulkheads.** Bulkheads fitted in large aircraft, hulls,

and floats which run in a fore and aft direction.

**Longitudinal Dihedral Angle.** The difference between the angles of attack of the wing and tail plane of an aeroplane. The angle is positive when the angle of attack of the tail plane is less than the angle of attack of the wing.

**Longitudinal Divergence.** The instability of motion which leads to a nose dive or stall. It is any non-periodic disturbance which increases longitudinally.

**Longitudinal Force.** The component along the longitudinal axis of the resultant force. It includes the resolved component of gravity. If the resolved component of gravity is neglected it is better to refer to the "longitudinal air force."

**Longitudinal Oscillation.** The motion of an aircraft which is made up of periodic variation of the speed of flight, angle of pitch, and attitude of the aircraft.

**Longitudinal Stability.** Stability with reference to the motions in the plane of symmetry involving pitching and forward motion. The ability of an aeroplane to remain longitudinally level or return to level flight when once disturbed.

**Longitudinal System.** Indicating the principle of construction of hull or float where main longitudinal members run unbroken through frames the entire length of the structure.

**Longitudinal Velocity.** The component velocity in relation to the air along the longitudinal axis.

**Loop.** A revolution of an aeroplane about its lateral axis, when the upper surface of the wings is on the inside of the curved flight.

**Loop Antenna.** A radio aerial

consisting of one or more turns of a wire arranged in a circle.

**Louvre.** A slotted opening or openings in an engine cowling for the purpose of admitting or discharging air.

**Low.** A term used in meteorology. It refers to an area of low barometric pressure.

**Low Altitude Bombing.** The term used to denote that the bombs were released at less than 1000 ft.

**Low Carbon Steel.** Steel whose carbon content is between 0.15 and 0.30 per cent.

**Low Clouds.** These are clouds with a mean height below 7000 ft.

See also NIMBO-STRATUS; STRATO-CUMULUS; STRATUS.

**Low Pressure Area.** An area of low barometric pressure created by warm air rising. A low pressure area normally contains storms.

See also DEPRESSION.

**Low Pressure Oxygen.** This is oxygen which is used for respiration purposes at high altitudes.

See also LIQUID OXYGEN.

**Low Tension.** A term indicating that the voltage is below 300 D.C. and 150 A.C.

**Low-wing Monoplane.** A monoplane which has its main supporting surface located near the bottom of the fuselage.

L.T. See LOW TENSION.

**Lubber Line.** A line across the card of a compass which is permanently aligned with the longitudinal axis of the aeroplane. It enables the pilot to keep on his course while flying with instruments only.

**Lubricant.** A substance having greasy or oily properties. It is used for the purpose of reducing friction between bearing surfaces, and also as a rust preventive on metal parts. Lubricants are classified as mineral, vegetable, or animal lubricants.



## M

**Mackerel Sky.** An area of the sky which is covered with cumulus clouds which appear to resemble the scales on a mackerel. The height may be from 7000 ft. to 20,000 ft.

**Maestro.** A north-westerly wind in the Adriatic. It occurs most frequently in winter and spring.

**Magnaflux.** A method of testing metal for flaws. In carrying out the test the part is first magnetized and then dipped into the "magnaflux" solution, which consists of an iron oxide mixed with paraffin. The iron oxide collects in the flaw owing to the magnetic lines of force. The results can be seen with the naked eye.

See also MAGNETIC EXAMINATION.

**Magnesium.** A chemical element, symbol Mg. It weighs 0.063 lb. per cub. in. It is used in small quantities with aluminium alloys as it improves the heat-treatment qualities.

**Magnesium Alloys.** These alloys are used in aircraft for many parts, such as crankcases, instrument casings, etc.

**Magnet.** A piece of material having the property of attracting iron and certain other substances. A magnet may be a natural magnet, such as lodestone, or an artificial magnet of iron base.

**Magnetic Attraction.** The force of attraction between materials which are natural magnets or of an iron base and have been magnetized. In magnetized conditions like poles repel and unlike poles attract.

**Magnetic Course.** The course as indicated by an angle, measured clockwise from the magnetic meridian, between the magnetic meridian and the longitudinal axis of the aircraft. A magnetic course is equal

to the compass course  $\pm$  deviation. A magnetic course is also equal to a true course  $\pm$  variation.

**Magnetic Declination.** This is the angle between the magnetic meridian and the true meridian as shown by the compass needle.

**Magnetic Examination.** The examination for flaws near the surface of a metallic item by magnetizing the metal to be tested. Dry, fine iron particles are then spread on the surface of the item to be tested. Flaws near the surface of the metal will cause an increase in the magnetic flux at that point. The result is a ridge of iron particles.

See also MAGNAFLUX.

**Magnetic Equator.** A line which extends round the earth. Along this line the dip of a compass needle is zero.

**Magnetic Field.** The name given to the region surrounding a magnet which contains the magnetic sphere of influence.

**Magnetic Flux.** The lines of force in a magnetic field.

**Magnetic Induction.** When a permanent magnet is placed in the near vicinity of a piece of iron the latter becomes magnetized. This is called magnetic induction. Similarly, if a bar of iron is placed inside a coil of wire through which an electric current is passing, the iron becomes magnetized by induction.

**Magnetic Lines of Force.** The lines along which a magnet exerts its force. These lines form the magnetic field.

**Magnetic Meridian.** The meridian which passes through the north and south magnetic poles of the earth.

**Magnetic North.** A term used to denote the direction toward the magnetic north pole.

**Magnetic North Pole.** The north magnetic pole. This pole attracts the north-seeking end of a compass needle. Its location is at latitude  $71^{\circ}$  N. and longitude  $96^{\circ}$  W. It is a fixed point and does not, as is generally supposed, vary year by year.

**Magnetic Poles.** The name given to the two positions on the earth's surface where terrestrial magnetism is at its maximum. The magnetic poles are a considerable distance from the north and south geographic poles.

**Magnetic Remanence.** When a piece of iron has been placed inside a coil of wire through which an electric current is flowing and the current in the wire is switched off, the magnetic field around the coil collapses, but the iron retains some of its former magnetism. This is called magnetic remanence.

**Magnetic Revolution Indicator.** An indicator which utilizes an engine-driven magnetic rotor to generate an electric current in an inductor. The inductor is held partially in check from turning by a calibrated spring. The magnetic effect on the inductor registers the revolutions per minute of the engine.

**Magnetic Screen.** Lines of force of a magnetic field pass more easily through iron than air. For this reason a wire carrying an electric current can be screened by an iron case, and so prevent the magnetic field flowing outside that case.

**Magnetic Tachometer.** See MAGNETIC REVOLUTION INDICATOR.

**Magnetic Track Angle.** The track angle with reference to the magnetic meridian as opposed to the angle between the aircraft track and a true meridian.

**Magnetic Variation.** This is the angle between the magnetic and the true meridian. Variation differs from place to place on the face of the earth for two reasons: (1) the magnetic meridian is not coincident

with the true meridian; (2) there are large local metallic deposits at certain places in the earth. A compass cannot be corrected for these variations. The navigator must, therefore, know the particular variation and place concerned. Variation is east or west, and depends upon whether the compass needle points east or west of the true meridian.

**Magnetite.** A natural permanent magnet and known as lodestone or magnetite. It is a compound of iron and oxygen ( $\text{Fe}_3\text{O}_4$ ).

See also LODESTONE.

**Magneto.** An electrical device which produces a high voltage electric current for the ignition of the fuel/air mixture in an internal combustion engine. A magneto consists of an armature which produces, when rotated, an electric current of low voltage in a primary circuit. This current is by induction raised to a high voltage in a secondary circuit.

**Magnitude.** This term refers to dimensions, such as size, weight, length, depth, volume, etc. In aeronautics it is used when referring to oscillations, etc.

**Mahogany.** Mahogany is a hard wood, the most suitable variety of which is obtained from British Honduras. It is used in the aircraft industry for the manufacture of wooden propellers.

**Main Beacon.** The beacon used in the standard beam approach system which emits a steady note. On one side of this beam is the dot area, and on the other the dash area.

**Main Float.** The main supporting surface of an aerodyne for landing on water.

**Main Frames.** Transverse frames of a hull or float that are of a more robust construction than ordinary frames, being built up and reinforced with stiffening members, etc.

**Main Longitudinal.** The girder

which is part of the structure of a rigid airship and forms an essential structural member.

**Main Mooring Wire.** The wire which passes through the mooring cone of an airship. It is connected to the ground wire from the mooring tower.

**Main Plane.** A main supporting surface of an aeroplane. This term includes the ailerons.

**Main Plane Structure.** The complete lifting surfaces of an aeroplane.

**Main Step.** The foremost step of a hull or float.

**Main Tank.** The tank, or tanks, in which the main supply of fuel is carried in an aerostat or aerodyne.

**Main Transverse.** One of the main strengthening frames of a rigid airship.

**Main Transverse Frame.** A system of members forming a complete ring which connects all the longitudinal girders of an airship.

**Make Fast.** The act of tying up or mooring a flying boat or float plane.

**Malleability.** That property of a material which enables it to undergo deformation without fracture under compressive loads, such as hammering or rolling.

Metals which are malleable at a red heat but are less so when cold are known as cold short, and if malleable when cold and less so when hot they are known as hot short.

**Malleable Iron.** A white cast iron. The average composition is carbon 2 per cent, silicon 1 per cent, manganese 0.25 per cent, with small quantities of phosphorus and sulphur. It is used for small castings.

**Mandrel.** A metal shaft or spindle which fits accurately into a jig or assembly. It holds or secures any part or fitting while machine, hand, or assembly work is being performed.

**Maneton.** The short end of a crankshaft in a radial engine. This

is detachable from the main crankshaft.

**Manganese.** A chemical element, symbol Mn. It weighs 0.2887 lb. per cub in., and is used as an alloy in certain types of steel.

**Manganese Bronze.** An iron and manganese brass which is very resistant to the corrosive action of salt-water. It has good resistance to high impact loads and is sometimes used for landing gear fittings for aircraft.

**Manifest.** A general declaration of cargo for Customs purposes.

**Manifold Pressure Control.** A method of controlling the power output of an internal combustion engine by the pressure in the induction manifold. The pressure is maintained by the engine supercharger. The throttle is operated in conjunction with the limits of engine r.p.m. and the pressure in the manifold.

See also AUTOMATIC BOOST CONTROL.

**Manifold Pressure Gauge.** An engine instrument which indicates the pressure in an induction manifold of an internal combustion engine. Manifold pressure gauges indicate the power output. Some aircraft engines are operated and regulated by manifold pressure readings.

See also BOOST GAUGE.

**Manoeuvrability.** That quality in an aircraft which indicates the ease or otherwise at which its attitude and direction of flight can be altered.

**Manoeuvre.** To operate an aircraft so as to cause it to perform evolutions which are not normal straight flight.

**Manoeuvring Valve.** A valve fitted to the envelope of an aerostat. It is operated by hand to release the gas as required for manoeuvring.

**Map.** A flat surface drawn to some convenient scale which represents

a portion of the earth's surface. The unit of linear measurement used in map making and map reading in the United Kingdom is the statute mile (5280 ft.).

**Mares' Tails.** Cirrus clouds which are in the form of long slender streaks.

**Marine Distress Signal.** A pyrotechnic device for use after an aircraft, which is in need of help, has alighted on the water.

**Marshal of the Royal Air Force.** This is the highest rank in the R.A.F. and is equal to the rank of Admiral of the Fleet in the Royal Navy, and Field Marshal in the Army. The distinctive arm badge is one thick ring of braid surmounted by four thinner rings.

**Martensite.** This is one form of carbon steel and is obtained when the steel is cooled very rapidly. Martensite is the hardest of the constituent forms and is also very brittle. It has a high tensile strength, but very little ductility. In order to produce it the steel must be quenched very rapidly from below the critical point.

**Mass.** A measure of quantity. It is not the same as weight. The weight of a body varies slightly at different points on the earth's surface because it depends on the force of gravity. The mass of a body does not alter, and is its weight divided by its acceleration due to gravity.

**Master and Articulated Connecting-rod Assembly.** An assembly in which the big end of the master connecting-rod carries the articulated connecting-rods. These articulated rods oscillate on wrist pins which are held in lugs or flanges on the master rod.

**Matrix.** A material in which a different substance is embedded. In Babbitt metal the matrix is tin, copper and antimony being embedded and not chemically mixed with the tin.

**Maximum.** The term used to indicate the highest value.

**Maximum Boost Horse-power.** The brake horse-power developed by a supercharged engine when it is running at its maximum permissible boost pressure and at its normal revolutions per minute under international standard atmospheric conditions.

**Maximum Horse-power.** The maximum power which is developed by an engine or transmitted by a shaft when running at maximum permissible revolutions per minute at full throttle.

**Maximum Permissible Boost Pressure.** Boost pressure which is permissible only during take-off and must not be exceeded.

**Maximum Permissible Revolutions per Minute.** The number of crankshaft revolutions per minute which can be maintained for periods not exceeding five minutes, and which should not be exceeded.

**Maximum Power Altitude.** The lowest altitude at which full throttle for a supercharged engine is permissible at maximum permissible revolutions per minute. It is also the highest altitude at which the rated boost pressure can be maintained when running the engine at maximum permissible revolutions per minute.

**Maximum Range.** The maximum distance an aircraft can cover under given conditions, i.e. by flying at the economical speed and at a defined altitude at all stages of the flight.

**Maximum Reading Accelerometer.** An accelerometer which measures the maximum acceleration in a defined direction.

**Maximum Revolutions per Minute.** The number of revolutions per minute which must not be exceeded.

See also MAXIMUM PERMISSIBLE REVOLUTIONS PER MINUTE.

**Maximum Thermometer.** A thermometer which records the highest temperature since the last reading was made.

**Mayo Composite Aeroplane.** A combination of two aeroplanes, one a flying boat and the other a float seaplane. The flying boat takes off with the float seaplane on its upper surface, and when the two are airborne the float seaplane is detached from the flying boat. The advantage is that the flying boat allows the float seaplane to start a flight with a much heavier load than it could take off with under its own engine power.

**Mean.** A term used to denote average.

**Mean Chord.** The measurement obtained by dividing the wing area of a tapered wing by the maximum dimension of the wing, projected at right angles to the chord.

**Mean Effective Pressure.** The average pressure exerted inside the cylinder on the piston of an internal combustion engine during the power stroke.

**Mechanical Convection.** A term used in meteorology which refers to the forcing of air upwards due to its deflection by barriers such as mountains and cliffs or by high pressure areas.

**Mechanical De-icers.** A number of pneumatic layers of fabric and rubber fitted and fixed to the leading edge of the wings and tail surfaces. The purpose is the removal of ice formations by periodically inflating and deflating the air cells or tubes formed by the layers of fabric and rubber.

**Mechanical Efficiency.** In an engine this is the ratio of the useful power output (after deductions have been made for internal mechanical and frictional losses) to the total power developed.

**Mechanical Equivalent of Heat.** One British Thermal Unit is equal to 778 ft.-lb.

**Mechanical Properties.** The general properties of materials, comprising ductility, elasticity, hardness, malleability, stiffness, strength, and toughness.

**Mechanical Starters.** See COMPRESSED AIR STARTER; INERTIA STARTER.

**Medium Altitude Bombing.** The term used to denote that the bombs were released between the height of 10,000 ft. (high altitude bombing) and 1000 ft. (low altitude bombing).

**Medium Bomber.** A medium-sized, fast aeroplane used for bombing.

**Medium Carbon Steel.** Steel with a carbon content between 0.30 and 0.60 per cent.

**Medium Clouds.** These clouds have a mean height of between 7000 ft. and 20,000 ft.

See also ALTO-CUMULUS; ALTO-STRATUS.

**Mega.** A prefix denoting 1,000,000.

**Megger.** A measuring instrument giving a direct reading of high resistance in ohms.

**Megohm.** 1,000,000 ohms.

**Melting Point.** The temperature at which a solid becomes liquid.

**Meniscus.** The curved upper surface of a liquid in a tube.

**Mercator Chart.** See MERCATOR PROJECTION.

**Mercator Map.** See MERCATOR PROJECTION.

**Mercator Projection.** A chart or map on which all meridians are shown as straight lines and at right angles to the parallels of latitude, which are also parallel lines. A Mercator projection is constructed on the principle of cutting the surface of the earth at the Equator and at the meridians and laying the surface flat so that the Equator is a straight line. The areas north and south are stretched sideways until the meridians touch. In order to compensate for the lateral stretching

the upper north and south areas must also be elongated.

The higher latitudes will, therefore, be on a larger scale of distance than the central portions.

**Mercerized Cotton.** A plain woven fabric which is manufactured from staple cotton. For aircraft purposes it must not exceed 4.5 oz. in weight per square yard.

**Mercurial Barometer.** An instrument for measuring atmospheric pressure. It employs the principle of balancing the atmospheric pressure against a column of mercury. Atmospheric pressure is 14.7 lb. per sq. in., and supports a column of mercury 29.92 in. in length.

**Mercury.** A chemical element, symbol Hg. It weighs 0.4913 lb. per cub. in., and is used in barometers for measuring atmospheric pressure.

**Meridian.** A great circle which passes through the North Pole and South Pole of the earth. Standard meridians are spaced at 15° intervals.

**Mesh Wiring.** A network of wires over the top of the gas bag of an aerostat. They are attached to adjacent main transverse frames. The wiring prevents the gas bag rubbing against the longitudinals.

**Metal Arc Weld.** A weld made by striking an electric arc between an electrode and the parts to be welded. The parts to be welded act as a conductor, and are fused at the point nearest the electrode.

**Metal Spinning.** The forming into circular shapes of thin malleable metals by forcing the metal over suitable dies which are rotated in a machine.

**Metallic Sodium.** Metallic sodium, which is an excellent conductor of heat, is used with satisfactory results as a cooling medium. It is light in weight and melts at 208° F. At operating temperatures it is a liquid and, therefore, transfers the heat by convection as well as

conduction. Exhaust valves filled within one-third full of metallic sodium are in use. By this means heat is transferred from the head of the valve to the stem, where it is passed to the cylinder head. Valves containing metallic sodium are sealed by welding or plugging at the end.

**Metallic Vee.** The lowest point of the rigging of a kite balloon which is brought to a single point to which the main cable is attached.

**Metallizing.** A method of spraying a thin coat of metal on to an object to prevent oxidation. The surface should first be prepared by sandblasting. A metal wire of the selected material is fed into an acetylene flame. This melts the wire and the small molten particles are sprayed on to the surface of the object to be metallized.

**Meteorograph.** A self-recording instrument for obtaining meteorological information. It measures two or more quantities such as temperature, pressure, and humidity.

**Meteorological Elements.** The elements from a meteorological aspect are pressure, temperature, wind direction and its velocity, humidity, cloudiness, visibility, sunshine, and precipitation.

**Meteorology.** Meteorology is the study of atmospheric phenomena and the forecasting of weather conditions. It has special branches which study the upper air (aerology), climate (climatology), etc.

**Metre.** The principal unit of length in the metric system. It is equal to 39.37 in.

**Metric System.** A decimal system of measurement. It is used for length, weight, volume, etc.

**Microbarograph.** An instrument which is used for recording small and very rapid variations of the pressure of the atmosphere.

**Micron.** A micron is a unit of length. It is  $\frac{1}{1000000}$  part of a milli-

metre, or one millionth of a metre.

**Microphone.** A device employed for interpreting sound waves in the form of electrical impulses—there is a specific electrical impulse corresponding to every sound.

**Microscopic Inspection.** A test of a part which is suspected of having a defect by using a microscope to enlarge the fault. The item being tested is destroyed by this test as it is sectioned before the microscope is used.

**Middle Clouds.** See MEDIUM CLOUDS.

**Mid-wing Monoplane.** A monoplane in which the supporting surfaces are located approximately half-way between the top and bottom of the fuselage.

**Mile.** This is a unit of measurement which varies according to the system being used. There is the aeronautical mile and the nautical mile (both of 6080 ft.), the statute mile of 5280 ft., and the geographical mile of 6087.2 ft.

**Milli.** A prefix used in the metric system of measurements. It denotes a  $\frac{1}{1000}$  part of a normal measurement.

**Millibar.** The thousandth part of a bar. 1 in. or 25.40 millimetres of standard mercury equals 33.90 millibars.

See also BAR.

**Mineral Lubricants.** Lubricants derived from crude oil as opposed to those obtained from vegetable matter. Mineral lubricants are normally used in aero engines.

**Minimum Flying Speed.** The minimum air speed in standard atmosphere of an aeroplane in level flight.

**Minimum Thermometer.** A thermometer which records the lowest temperature which has been reached since the last reading.

**Mirage.** A visual displacement of objects by abnormal atmospheric

refraction. The images may be inverted and magnified, and in some cases seem to be very close to the observer.

**Mist.** A slight fog which is due to the condensation of moisture in the atmosphere.

**Mistral.** A cold wind of a dry nature on the Mediterranean coast of France blowing from the south or south-west.

**Mixture Control.** A device incorporated in the carburettor of an internal combustion engine which controls the necessary variation of mixture strength with altitude. With increased altitude the air becomes more rarefied and less fuel is required to maintain the ideal fuel/air mixture for perfect combustion.

**Mixture Ratio.** The proportion of the fuel to air which is necessary for the complete combustion of the mixture in the cylinders of an internal combustion engine. The proportion is expressed on a weight basis. The reason for this is that volumetric measurements would not be accurate owing to the variations in pressure and temperature. The normal proportion of air for complete combustion is 15 lb. to 1 lb. of fuel.

**Mock-up.** A full-sized dummy model of an aeroplane, usually made of wood. The purpose of the mock-up is to arrange seats, controls, etc., before completing the detailed drawings.

**Modulus of Elasticity.** For any given material this is the ratio of the stress to the strain. A modulus of elasticity of 30,000,000 lb. per sq. in. is the result of a unit stress of 21,000 lb. per sq. in. divided by a unit deformation of 0.0007 in. per in.

**Moisture Content.** This refers to the percentage of moisture in green or only partially dried woods. The moisture content of green wood

ranges from 33 to approximately 100 per cent.

**Molecule.** The smallest particle of any substance. It varies in size according to the substance. The size of a molecule is governed by the number of atoms in it.

**Molybdenum.** A chemical element, symbol Mo. Molybdenum is alloyed with steel for the purpose of refining the grain and also to act as a hardening agent.

**Moment.** The moment of a force is the product of the force and its perpendicular distance from a given point.

**Moment of Inertia.** This is the sum of the products of the mass of each elementary part of a body and the square of its distance from a given axis.

**Momentum.** The quantity of motion or the momentum of a moving body is measured by the product of its mass and velocity. It is recorded in pounds feet per second. It is the result of force which would bring a body to rest or cause a body to move.

**Monel Metal.** An alloy of nickel which is very resistant to corrosion. It contains nickel 67 per cent, copper 28 per cent, iron, manganese, and silicon 5 per cent.

**Monocoque.** A structure in wood or metal in the form of a skin or shell. The main loads in the structure are taken by the skin.

**Monocoque Fuselage.** A fuselage construction in which the strength of the skin or shell carries the loads. It has the advantage of having little or no internal structure.

**Monoplane.** An aeroplane which has only one main supporting surface. This main supporting surface may be continuous or in two sections, one on either side of the fuselage.

**Monospar.** This is a type of wing construction in which a single spar is used instead of the more usual

two spars with internal bracings. The spar must be so manufactured that it has little or no tendency to twist. This method has been used successfully in tapered cantilever monoplane wings. A saving in structural weight is claimed for it.

**Monsoon.** A wind blowing more or less steadily in certain regions and which blows from the interior towards the sea in winter and towards the land in the summer. In India the term is used to refer to the seasonal rains without reference to the wind.

**Mooring Area.** An area of water reserved for the mooring of flying boats or float planes.

**Mooring Band.** A reinforcing band over the upper surface of an aerostat. It takes the tension of the mooring guys when housing or picketing the aerostat.

**Mooring Bridle.** A collection of ropes or wires attached to a number of points on the envelope of an aerostat to distribute the tension of the main mooring wire.

**Mooring Coupling.** An attachment for connecting the wires of an airship to the ground wires. It is designed for rapid attachment.

**Mooring Eye.** A fitting attached externally to a hull or float at convenient places for the attachment of mooring gear.

**Mooring Gun.** The conical member at the extreme forward point of an airship which provides a coupling between the hollow gun at the top of the mooring tower and the forward point of the airship.

**Mooring Guy.** A rope for securing an aerostat when in its hangar or when it has to be picketed down in the open.

**Mooring Mast.** A mast which is erected for the sole purpose of mooring an airship.

**Mooring Point.** A part of an airship or the rigging which has been specially strengthened and



from which mooring wires are led.

**Mooring Rope.** A rope which is dropped from an aerostat to allow it to be secured by a landing party.

**Mooring Tower.** A permanent structure to which an airship can be moored. It is provided with facilities for embarkation and disembarkation. Fuel, gas, and ballast can be replenished by the use of this tower.

**Moorings.** Buoys attached to a heavy anchor. Flying boats and float planes can be made fast to these moorings.

**Morse Code.** A signalling code in the form of a combination of dots and dashes. One dash is equal in duration to three dots.

**Mosaic.** An air photographic map which is made up of a number of overlapping vertical air photographs. These when assembled form a complete photographic picture of the area and the whole is known as a mosaic.

**Mountain Breeze.** A katabatic

wind which blows down valleys and mountain slopes. It normally occurs in winter or at night.

**Multi-cylinder Head.** A casting usually containing the valves and covering a number of cylinders of an internal combustion engine.

**Multi-element Cooler.** A cooler used in the lubrication system. It is composed of a number of cooling units.

**Multiplane.** Any aeroplane which has two or more main supporting surfaces.

**Multiple Fabric.** Fabric which is formed of more than one ply. It may consist of many layers.

**Mushroom Head Rivet.** A rivet used for thin sheets, similar to the round head rivet. This rivet is used only if the head has a very light load to carry.

**Mutual Induction.** When two coils through which electric currents flow are placed in each other's magnetic field, a change in the one will induce an e.m.f. in the other, and vice versa, hence the term *mutual* induction.

## N

**Nacelle.** A body which is fastened to the wing for the purpose of enclosing the crew, engine, etc.

**Naphtha.** A clear and volatile liquid which is distilled from coal tar. It is used as a thinner for some paints. It is highly inflammable.

**National Physical Laboratory.** This is situated at Teddington, Middlesex. It was founded in the year 1899, as a public institution for standardizing and verifying instruments, for testing materials, and for the determination of physical constants.

**Nautical Mile.** A mean length of a minute of latitude, i.e. 6080 ft. At the Equator it is 6045.7 ft. and at the poles 6107.9 ft.

See also KNOT.

**Naval Brass.** A copper-base alloy used in aircraft for miscellaneous purposes where good bearing properties are necessary. It contains about 60 per cent copper, 39 per cent zinc, and 1 per cent tin.

**Navigation.** The term used when referring to the science of guiding a ship from one place to another and the ability to determine its exact position at any time.

See also AIR NAVIGATION.

**Navigation Flame Float.** A pyrotechnic device which is dropped from an aircraft on to the water for determining the drift angle.

**Navigation Flare.** A flare which is dropped from an aircraft on to the land and is used for determining the drift angle of an aircraft.

**Navigation Lamp.** A lamp fitted to an aircraft for indicating the aircraft's position and its direction of flight.

**Navigation Smoke Float.** A pyrotechnic device which is dropped from an aircraft on to the water for indicating the wind direction, or it

may be used for determining the drift angle.

**Navigators' Licences.** There are two grades of Aircraft Navigators' Licences, 1st Class being the higher qualification.

A 1st Class navigator must under international law be carried on every aircraft used for the carrying of passengers and goods, if it has to fly without landing—

(a) More than 625 miles entirely over the high seas or uninhabited regions; or

(b) More than 625 miles by night.

A navigator, either 1st Class or 2nd Class, must be carried if the aircraft has to fly without landing—

(a) More than 100 miles over inhabited regions, or more than 100 miles, but not more than 625 miles, over the high seas or uninhabited regions; or

(b) By night, more than 100, but not more than 625 miles.

Applicants for these licences may be of either sex and must be between the ages of 19 and 50. They are required to pass medical and theoretical examinations, besides having had air experience as an operative member of the crew of an aircraft.

**Neck.** A tube which is situated at the lower part of a balloon envelope for the automatic discharge of gas during flight. It can also be used for inflation and deflation of the envelope.

**Negative Pole.** Sometimes used with reference to a negative electrode or terminal.

**Nephoscope.** A meteorological instrument used on the ground for determining the wind velocity and direction by observing cloud movements. A darkened mirror is used; the movement of the cloud image

on this mirror is converted into wind direction and velocity in relation to a point on the earth's surface.

**Net Dry Weight.** The weight of an engine including ignition system (bonding and screening), carburetors, induction system, engine-driven fuel pump, water outlet collector pipes, interconnecting rods for carburetors or magnetos, starting gear and accessory drives, supercharger and the necessary connexions. It excludes exhaust branch pipes or manifolds, pipes connecting water outlet collector and water pump to the radiator, air intakes, water and oil.

The propeller hub is not included in the net dry weight.

**Net Weight.** The gross weight, less the weight of some specific part which should always be clearly defined.

**Nets.** See FREE BALLOON NET; INFLATION NET.

**Neutral Angle Air Intake.** An air intake whose entry has been so shaped as to minimize the effect of forward speed on carburation.

**Neutral Flame.** An oxy-acetylene flame in which the mixture of oxygen and acetylene is so adjusted that there is no excess of either gas. Excess oxygen produces an oxidizing flame, and an excess of acetylene a reducing flame.

**Neutralizing Controls.** Placing the controls of an aeroplane which is on the ground in a position such that the elevator, ailerons, and rudder occupy the same position as in normal level flight.

**Newton's Laws of Motion.** (1) Every body continues in a state of rest or of uniform motion in a straight line except in so far as it may be compelled by force to change that state.

(2) Rate of change of momentum is proportional to the impressed force, and takes place in the direc-

tion of a straight line in which the force acts.

(3) To every action there is always an equal and opposite reaction.

**N.F.** Letters used to denote night fighter aircraft. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Mosquito N.F. XV.

**Nibbler.** See NIBBLING MACHINE.

**Nibbling Machine.** A machine consisting of a die and punch, mechanically operated at high speed. It is used to cut out metal parts of intricate shape.

**Nickel.** A chemical element, symbol Ni. It weighs 0.3182 lb. per cub. in. Used in small quantities in special steels.

**Nimbo-stratus.** A dense layer of dark, shapeless clouds with ragged edges, from which rain or snow generally falls.

**Nimbus.** A ragged, low, dark grey cloud which is associated with bad weather. It may be continuous or fragmentary.

**Nitralloy.** The name of a chromium-alloy steel. It is surface-hardened by the process of nitriding.

**Nitrate Dope.** Dope with a nitro-cellulose base. Very inflammable. It has good fabric-tightening qualities.

**Nitriding.** A process used to give the surface of steel great resistance to wear; it is similar to case-hardening but nitrogen is absorbed by the steel instead of carbon. The steel is soaked in ammonia at a moderately high temperature.

See also CASE-HARDENING.

**Nitrogen.** A chemical element, symbol N. It is the chief constituent in air.

**Non-destructive Test.** This is a test which is carried out by applying gradually a static load to a structure to determine the amount of deformation. The test ceases when the operator is satisfied that the

structure will take the loads safely and without damage.

The term is also applied to tests made on materials or finished parts in order to determine the condition of the structure. The test does not damage the specimen. The hardness testing of metals is an example of a non-destructive test.

**Non-ferrous Metal.** A metal or its alloy which has no iron base. Aluminium and copper are examples of non-ferrous metals.

**Non-return Flow Wind Tunnel.** Any wind tunnel in which the airstream after passing through the tunnel is discharged into the housing and is not returned to the tunnel.

**Non-rigid Airship.** An airship in which the shape of the envelope is maintained by the internal pressure of the gas. It has no rigid keel.

**Normal.** In engineering the word "normal" means at right angles to, i.e. the normal axis is at right angles to the longitudinal axis.

**Normal Axis.** An imaginary line which passes through the centre of gravity of an aeroplane in the plane of symmetry. This axis is vertical when the lateral and longitudinal axes are horizontal. When the normal axis is downwards it is known as positive.

**Normal Flight.** This comprises all manoeuvres necessary for ordinary flying. It includes taking off and alighting, horizontal straight flight, flight at normal climbing and gliding angles, turns carried out when flying horizontally and at normal climbing and gliding angles, and side-slips made for the purpose of losing height or counteracting drift.

**Normal Force.** The component of the resultant force along the normal axis of the aeroplane. It includes the resolved component of gravity.

If the gravity component is neglected the term "normal air force" should be used.

**Normal Revolutions per Minute.** The highest number of crankshaft revolutions per minute which may be maintained continuously.

**Normal Velocity.** The component velocity in relation to the air measured along the normal axis.

**Normalizing.** A method of heat-treatment which relieves the internal stresses due to previous working on the metal. The metal is heated to a temperature exceeding its upper critical range and maintained there for about 15 minutes, after which it is allowed to cool in the air. After normalizing, the steel is in its best condition for machining.

**Normally Aspirated Engine.** An engine in which the fuel/air mixture enters the cylinder at existing atmospheric pressure and temperature. Colloquially, a non-supercharged internal combustion engine.

**Norte.** A cold, dry, northerly wind over the Gulf of Mexico.

**North Star.** The name applied to the star Polaris, which gives an approximate line to the true north. The north star varies its position very little in the celestial sphere, and is never more than  $2\frac{1}{2}^{\circ}$  in bearing from the pole in latitudes less than  $60^{\circ}$ . It is therefore a valuable aid in navigation.

**Northerly Turning Error.** The error which exists in an ordinary magnetic compass when an aeroplane is banked and turning off a northerly or southerly course. During the bank, the compass card is tilted with the aeroplane; the dip of the needle turns the card in the direction of the aeroplane's turn if from a northerly course and opposite to the turn if from a southerly course.

**Northern Hemisphere.** The part of the earth which is to the north of the Equator.

**Nor' Westers.** These are disturbances of the line squall type occurring in Bengal and Assam,

and are associated with thunderstorms. They are sharply restricted in area and frequently very destructive. Normally they occur late in the afternoon and sweep the country in straight paths from north or north-west to south or south-east. They occur in the latter half of February.

**Nose Dive.** The attitude of an aircraft when diving almost vertically.

**Nose Fairing.** An addition to the nose structure of an aircraft to reduce head resistance.

**Nose Piece Radiator.** A liquid cooler fitted in front of the fuselage or nacelle.

**Nose Rib.** The rib which is situated between the front spar and leading edge of the main planes or controlling surfaces of an aeroplane.

**Nose-down.** To depress the nose of an aeroplane by the use of the elevator in flight. Alternatively, the term is sometimes used to indicate that the rigging of the aeroplane is incorrect and the nose tends to be down in normal flying conditions.

See also NOSE-HEAVY.

**Nose-heavy.** The condition in which the nose of an aeroplane tends to fall when the longitudinal control is released when in level flight. This is due to incorrect rigging.

**Nose-up.** To elevate the nose of an aeroplane by the use of the elevator in flight. Alternatively, the term is sometimes used to indicate that the rigging of the aeroplane is incorrect and the nose tends to be up in normal flying conditions.

**Notched Bar Test.** See IZOD TEST.

**Notices to Airmen.** These are issued by the British Air Ministry. They are of an explanatory or warning character.

**N.P.L.** See NATIONAL PHYSICAL LABORATORY.

**N.T.P.** Normal temperature and pressure, i.e.  $0^{\circ}\text{C.}$ , 14.7 lb. per sq. in.

**Nurse Balloon.** A container made of fabric used either as a gas reservoir or for the purpose of maintaining a constant pressure in an aerostat on the ground.

## O

**Oblique Air Photographs.** Air photographs which are taken at any angle other than vertical.

**Observation Balloon.** A captive balloon used for the purpose of observation.

**Observation Mirror.** A mirror which is engraved and used for the same purpose as a camera obscura.

**Obstruction Lights.** A light for indicating the presence of any obstructions which are dangerous to aircraft in flight or moving on the ground.

**Obturator Ring.** A gas ring "L" shaped in cross-section which is used as an extra means of gas tightness over a spring ring. Not used in modern engines.

**Occlusion.** The front which remains after the cold front of a depression has overtaken the warm front, the warm having risen from the surface of the earth.

**Oculuting Light.** An intermittent light in which the duration of the dark period is shorter than that of the bright period.

**Octane Number.** The octane number of a fuel is a measure of its ability to resist detonation. To measure the anti-knock value, two hydrocarbons are used, one heptane, being a high detonation spirit, and the other, iso-octane, being a low detonation spirit. The former is given a rating of 0 and the latter 100. By blending these two in the correct proportion, a mixture is made which duplicates the fuel under test in its tendency to knock.

**Octane Rating.** A term which is used to indicate the maximum pressure to which a vaporized fuel may be compressed inside an internal combustion engine cylinder without detonation. Fuels have definite limits to which they may be com-

pressed, and in excess of this limit the fuel will detonate. The development of higher anti-knock fuels has allowed the use of higher compression ratios with the consequent increase in power output.

**Octant.** A type of the aircraft sextant which measures angles up to 90 degrees.

**Ohm.** An electrical unit of resistance. It is the resistance of an electrical circuit in which a difference of potential of one volt produces a current of one ampere.

**Ohmic Resistance.** The resistance of a direct current circuit.

**Oils.** Oils can be divided into three groups—mineral, vegetable, and animal. Mineral oil is that generally used for aeronautical purposes. Vegetable oil has been used and is occasionally mixed with mineral oil for specific purposes. Animal oil is not used.

The main constituents of mineral oil are carbon and hydrogen. From the raw material petrol, fuel oil, paraffin wax, and many other materials are manufactured.

Oil is used as a lubricant for reducing the friction between moving parts.

**Oil Tank Coolers.** See AIR TUBE COOLER; MULTI-ELEMENT COOLER; OIL TUBE COOLER; ROTARY JET COOLER; TANK COOLER.

**Oil Tube Cooler.** A cooler in which the oil passes inside the tubes which are exposed to an air stream.

**Oil-breather.** A large opening used to conduct oil vapours from the engine sump.

**Oleo Gear.** A type of oil-damping device for absorbing shock in the landing gear of an aircraft.

See also OLEO STRUT.

**Oleo Strut.** This is part of the

oleo gear and is a shock-absorbing telescopic strut. It is partially filled with oil in which a piston reciprocates and absorbs the landing loads by forcing the oil through a small orifice.

**One Atmosphere.** One atmosphere has an air pressure of 14.7 lb. per sq. in., and is equal to 29.92 in. of mercury at 59° F.

See also ATMOSPHERIC PRESSURE.

**Open Hearth Steel.** Steel made in an open furnace by the melting of 70 per cent of pig iron, 30 per cent of iron scrap and steel scrap, with the addition of pure iron ore until the carbon is reduced to the required percentage. Open hearth steel is of uniform quality.

**Open Jet Wind Tunnel.** A wind tunnel in which the airstream passing the body under test is not confined by the tunnel walls.

**Opposed Cylinder Engine.** An engine whose cylinders are arranged opposite to each other in the same plane. The connecting-rods work on the same crankshaft.

**Opposed Piston Engine.** An engine in which the compression is effected by two pistons in the same cylinder. The pistons approach one another to create the necessary compression.

**Optimum Angle of Incidence.** The angle of incidence at which the lift-drag ratio of an aerofoil is the greatest. At this angle of attack the maximum efficiency is obtained.

**Ordinates.** The vertical distances above or below a datum horizontal line on a graph.

**Orienting a Map.** Placing a map so that the north line on the map points due North.

**Ornithopter.** A flying machine of the heavier-than-air type which obtains its lift by flapping motion imparted by mechanical means, such as oscillating wings.

**Orographic Rain.** Rain which is caused by air being forced upwards because it is blowing up the sides

of rising land in the path of moisture-laden wind.

**Oscillations.** See LATERAL OSCILLATION; LONGITUDINAL OSCILLATION; PHUGOID OSCILLATION; STABLE OSCILLATION; UNSTABLE OSCILLATION.

**Otto Cycle.** This is the cycle which is generally used for internal combustion engines. It is not the cycle of operation, which is mechanical and is of two or four strokes. In the otto cycle a fuel/air mixture is taken into the cylinder, ignited, and is followed by the expansion of the air, thus enabling work to be performed.

**Out of Alignment.** A term used to indicate that items are out of truth, e.g. a propeller having the blade sweep of one blade out of line with that of the other or others.

**Out of Pitch.** A propeller having one blade angle different from that of the other or others at the same radius.

**Outboard Float.** A stabilizing float which is fitted to a flying boat or float plane near the tip of each wing.

**Outer Cover.** In addition to its normal usage to denote rubber tyres, this term refers to the outer covering of the hull of a rigid airship.

**Outer Marker Beacon.** A beacon which emits in a vertical direction a radio signal with special characteristics. It is situated about two miles from the main beacon, and in the line of approach in the standard beam approach system.

**Outflow.** A term used to denote the increase in air velocity behind a propeller which is produced by its rotation.

**Outside Loop.** A loop in which the pilot is on the outer side of the flight path.

**Overhead Valve Cylinder.** A cylinder in which all the valves are in the head with their stems up-

wards, usually operated by rockers from an overhead camshaft or direct from the cams.

**Overshoot.** To continue beyond the perimeter of the area when attempting to land an aircraft.

**Overswing.** The general tendency for a suspended needle to swing too far when it has been disturbed by the aircraft making a sudden change in direction.

**Oxidation.** The chemical action in which oxygen combines with certain elements. This combination is very rapid in an explosion, as in the expansion of the gases due to the burning of the mixture in an internal combustion engine cylinder, and slow in the case of the rusting of metals.

**Oxidizing Flame.** An oxy-acetylene flame in which the oxygen is in too large a proportion.

**Oxygen.** A chemical element, symbol O. It is the most widely distributed of the chemical elements. It is a colourless, odourless, and tasteless gas. It exists in the atmosphere in a free state to the extent of 21 per cent by volume. It combines with a great number of elements. At high altitudes, oxygen is used to assist the personnel in the aircraft to breathe.

See also LIQUID OXYGEN.

**Oxygen Economizer.** This is an oxygen reservoir which is used by aircrews when flying at high altitudes. It consists of a small canvas bag housed in a metal box. A valve attached to the canvas bag allows the oxygen to escape through the tube to the mask. The suction due to the breath lifts the valve and partially empties the bag, the bag being refilled automatically from the oxygen bottle. The oxygen is used only when breathing in.

**Oxygen Equipment.** It is necessary to provide a special supply of additional oxygen for personnel flying at high altitudes. Lack of oxygen increases the action of the heart necessary to maintain the blood circulation and consequent decrease of muscular strength, accompanied by the gradual dulling of the perceptions and judgment. Two methods of supply are normally used—

(i) Liquid oxygen stored at low pressure in special bottles.

(ii) Gaseous oxygen compressed at high pressure in steel cylinders.

**Ozone.** A form of oxygen which occurs in very small quantities in the lower atmosphere. Its molecular construction is three atoms, whereas that of normal oxygen is two atoms.



## P

**Pack.** The bag in which a parachute is packed.

See also PARACHUTE PACK.

**Pampero.** The name given to certain line squalls in the Argentine and Uruguay, the wind changing to the south-west.

**Pancake Landing.** See PANCAKING.

**Pancaking.** Landing with the aeroplane in an over-stalled attitude. The normal or perpendicular velocity being too high, the tail skid may touch the ground first with the possibility of damage to the aeroplane.

**Panel.** Where a surface, either wing or cowling, of an aeroplane comprises several separate units, these units are known as panels. In aerostats a panel is a section of a gore.

**Parachute.** A device used to reduce the acceleration of a falling body by offering resistance to its motion through the air. It is umbrella-shaped.

See also AUTOMATIC PARACHUTE; AUXILIARY PARACHUTE; FREE PARACHUTE.

**Parachute Canopy.** The supporting surface of a parachute. It is made of silk and decreases the acceleration of the falling load.

**Parachute Diameter.** The overall diameter of the canopy when opened on a flat surface in a collapsed condition.

**Parachute Fabric.** The term applied to the special fabric used for the canopy of a parachute. It is manufactured from high-grade silk, and is exceptionally strong.

**Parachute Flare.** A pyrotechnic device used by the R.A.F. to indicate a target and dropped by Pathfinders prior to a bombing attack. It is attached to a parachute which falls slowly and illumi-

nates the target for a long period of time.

**Parachute Harness.** There are many types, each of which depends upon individual requirements of the aircrew; but all types consist of straps and fastenings which attach the parachute to the wearer.

**Parachute Licence.** Parachute descents other than in cases of emergency are not allowed in Great Britain except by holders of a special licence issued by the Air Ministry. This is called the Exhibition Parachutist's Licence. An applicant is eligible if he has made at least ten trial descents (temporary permits are issued for this purpose) and must hold a Ground Engineer's Licence in Category X, Section 3.

The licences are valid for a period up to a maximum of twelve months.

**Parachute Pack.** This term is used when referring to both the container and the parachute.

See also PACK.

**Parachute Rip Cord.** The cord which runs through a small diameter tube from the pull ring to the locking pin on the parachute pack. When the rip cord extracts the locking pin it releases the pilot parachute, which in turn releases the main parachute.

**Parachute Shroud Lines.** These cords are continuous from one side of the parachute harness to the other, and pass over the top of the parachute canopy. They are of specially selected silk, and have a tensile strength of approximately 400 lb. per sq. in.

**Parachute Travelling Bag.** A bag for transporting a parachute in its pack.

**Parachute Vent.** Air opening in the top of the canopy of a parachute. This relieves any excess

pressure and assists in stabilizing the parachute during its descent.

**Parallel Fabric.** A multi-ply fabric in which the threads of all the layers are parallel. Used in balloons.

**Parallel Rulers.** This instrument is used by navigators, and consists of two straight edges joined by bars which are pivoted so that the edges of the straight edges are always parallel.

**Parasite Drag.** That part of the drag of an aircraft other than the induced drag, i.e. the drag produced by bad finishing, doping, or by protruding rivets, etc.

**Parasite Resistance.** See PARASITE DRAG.

**Parasol Monoplane.** A monoplane in which the supporting surface is above the fuselage, i.e. the fuselage is underslung by external bracing members from the main plane.

**Parkerizing.** A process which provides a protective coating on iron and steel parts against corrosion.

**Pay Load.** That part of the total load of an aircraft from which revenue is derived, e.g. passengers and freight.

**Pennant.** See ROYAL AIR MAIL PENNANT.

**Performance.** The flying characteristics of an aeroplane. The following are some of the requirements—

(a) Maximum and minimum level flying speeds at various altitudes.

(b) Rate of climb at defined altitudes.

(c) Time necessary to climb to defined altitudes.

(d) Landing speed.

(e) Best gliding angle.

(f) Service ceiling.

(g) Absolute ceiling.

**Performance Testing.** The method used for estimating the performance of an aeroplane.

See also PERFORMANCE.

**Period.** The time taken for a

complete oscillation or vibration. A periodicity is the regular recurrence of the same phenomena at the same times. The term is also used in astronomy to indicate a definite cycle of years for a celestial body to complete a revolution in its orbit.

**Periscope Drift Angle Sight.** An instrument which employs a periscope for determining the drift angle. It enables an image of the earth's surface to be seen in the aircraft.

**Permanent Magnet.** A piece of metal which retains its magnetism permanently after it has once been magnetized.

**Permanent Under-Secretary of State.** A member of the Air Council who is responsible for the policy, exchequer, purchases, accounts, public relations, and administration.

**Permeability.** The ratio of the number of magnetic lines of force which will pass through a given space when occupied by a substance to the number of lines of force which will pass through when it is occupied by air.

It also refers to the measure of the rate of loss of gas through a balloon fabric under standard conditions of pressure and temperature.

**Petrol.** A trade name for a fuel used in internal combustion engines consisting of a mixture of volatile fractions of the paraffin, naphthene, and aromatic series of hydrocarbons.

**Phenolic Plastics.** This is the name given to a "thermo-setting" resin used in the "Plastics" industry, being so classified because it flows at a certain temperature, but once it has been cooled will not again become plastic on being re-heated.

It is made from carboic acid (phenol) or cresylic acid (cresol) and formaldehyde; the former are by-products of coal-tar whilst the latter is a product of wood distillation.

This is one of the most commonly used plastics.

**Photometer.** Used to determine candle-power and illumination.

**Phugoid Oscillation.** An oscillation of long periodicity which is characteristic of a disturbed longitudinal motion. This condition exists when an aeroplane "hunts."

**Pickling.** A method used for the removal of oxides, etc., from metals. Carbon steels are pickled in solutions of hydrochloric or sulphuric acid for this purpose. Different acids are required for other metals.

**Pigmented Dope.** A clear dope used as the final finish to aircraft fabric to which finely ground particles of pigment or colour are added. The pigment is held in suspension for a considerable time after being mixed.

**Pilot.** The individual who operates the flying and operating controls of an aircraft in flight. In large multiple-engined aircraft the control and operation of the engines and fuel systems may be the responsibility of the flight engineer under the orders of the pilot.

**Pilot Balloon.** A small balloon filled with hydrogen which is sent up to show the direction and speed of the wind. The motion of the balloon is observed through a theodolite. Readings are taken each minute.

**Pilot Officer.** The junior commissioned rank in the Royal Air Force. The indicating band on the arm is a thin ring of braid.

**Pilot Parachute.** A small auxiliary parachute which is attached to the top of the main parachute. This small parachute extracts the main parachute from its pack.

**Pilotage.** Estimating the course and the position by reference to visible objects on the earth's surface.

**Pilotless Aeroplane.** This is an aeroplane which is controlled both as regards direction and height by

a radio beam or by gyroscopes. In the radio beam type the aeroplane is of the normal construction. As regards the gyroscopic controlled type, see FLYING BOMB.

**Pilots' Licences.** See "A" LICENCE (PILOT); PRIVATE PILOT'S LICENCE.

"**Pinking.**" See DETONATION.

**Pipes.** See FEED PIPE; SCAVENGER PIPE; TANK VENT PIPE.

**Pistol.** A mechanical device used in bombs and torpedoes for administering the necessary force to fire the detonator.

**Piston.** The reciprocating part of an engine which takes the force of the expanding gases in the combustion chamber and by means of which the power is transformed into rotary motion by the connecting-rod and the crankshaft.

**Piston Rings.** Piston rings, which are manufactured from a special grade of cast iron, seal the combustion chamber of an internal combustion engine against loss of pressure. The rings fit into grooves cut in the circumference of the piston. In addition to sealing the piston against loss of pressure, they prevent the lubricating oil entering the combustion chamber.

**Pitch.** The angular motion about the lateral axis of an aircraft. It is called positive when the nose of the aircraft rises, and negative when the nose falls.

The term also refers to the centre to centre distance between the rivets in any row of rivets.

The distance a propeller would advance in one revolution if there was no slip is the pitch, i.e. it is the amount the propeller would move forward in one revolution if it were acting in a medium, such as a metal, which would allow of no slip.

**Pitch, Angle of.** See ANGLE OF PITCH.

**Pitch Indicator.** An instrument which indicates the angular

movement about the lateral axis of an aircraft.

**Pitch Ratio.** The ratio of the pitch of a propeller to the diameter.

**Pitching.** The angular or up and down movement from level flight of an aeroplane about the lateral axis.

See also **PITCH**.

**Pitching Moment.** A moment which causes the nose of the aeroplane to rise or fall. When the nose rises it is a positive or stalling moment, and when the nose falls it is a negative or diving moment.

**Pitot Tube.** Part of the pitot-static tube. It is the open-ended tube facing the airstream which assists in registering the air speed of an aircraft in flight.

See also **PITOT-STATIC TUBE**.

**Pitot-static Tube.** A device which consists of two tubes, one having its orifice in the airstream. One of the tubes has the end closed, but has holes on the side so that static air pressure is maintained in the tube. The other tube has an open end, and therefore receives the full pressure of the airstream. The difference between the static pressure and air pressure due to speed is registered on an instrument which indicates the air speed of the aeroplane.

**Plain Bearing.** The simplest form of bearing used for rotating shafts. It normally consists of a phosphor-bronze shell, sometimes with a white-metal lining.

**Plan View.** The view of an object as seen from above.

**Plane.** The wing of an aircraft.

See also **AEROFOIL**.

**Plane of Reference.** This term is used in connexion with a hull or float and means a plane perpendicular to the plane of symmetry. Starting from it the ordinates, which define the exterior form, are counted.

The intersection of the plane of

reference with the plane of symmetry is called the line of reference.

**Plane of Symmetry.** A geometrical plane which passes vertically through the longitudinal axis of an aeroplane. It is used as a datum or reference line. On both sides of this datum line the aeroplane should be symmetrical.

**Planetary Winds.** This term is used when referring to the normal movement of the air over the earth's surface.

**Planing Bottom.** The underside of the hull of a flying boat. It is specially shaped and made smooth to decrease resistance.

**Plasticity.** The plasticity of a material is that quality which allows it to be shaped without difficulty.

**Plastics.** Substances that can be formed into a desired shape by the application of heat and pressure. They are not substitutes for natural materials, but new materials with many attributes which no natural material possesses. There are two categories, thermo-plastics and thermo-setting plastics.

See also **ACRYLIC AND VINYL**; **CELLULOSE PLASTICS**; **PHENOLIC PLASTICS**; **THERMO-PLASTICS**; **UREA**

**Platinizing.** A treatment which provides a protective coating of zinc to the external surface of steel parts.

**Pliofilm.** This is a material used for protecting aero engines, instruments, and parts of aircraft structures from corrosion due to atmospheric conditions or sea-water. The engine or other component is placed in a hermetically sealed envelope made of this material. It is transparent and manufactured in sheets from pure rubber. The envelopes are specially designed to suit the equipment and are secured by means of gaskets or washers.

This material is thermo-plastic, and is readily sealed by the application of heat. The joint made will

not allow moisture into the inside of the envelope.

**Plotted.** A term which indicates that certain information such as that required to lay out a compass course has been graphically represented.

**Plug Gauge.** A gauge, the outside surfaces of which are ground accurately and are used to check the accuracy of holes. A plug may be threaded, in which case it is used to test the accuracy of internal threads.

**Plywood.** Name given to built-up plies or thin veneers of wood. The grains of each layer are at right angles to those of the next, and the layers are cemented or glued together. Plywood has great strength in relation to solid timber. It is used for many purposes in aircraft construction.

**Plymetal.** A wood panel which has on both sides an aluminium alloy sheet permanently fixed by an adhesive material. It is used in some large aircraft as floor-boards.

**Poisson's Ratio.** A structural member subject to direct stress is under longitudinal strain and also a transverse strain. Poisson's ratio expresses the relationship between the longitudinal strain and the transverse strain.

**Polar Air.** See POLAR AIR MASS.

**Polar Air Mass.** A large air mass which starts in polar regions and causes depressions in temperate latitudes.

**Polar Front.** The demarcation which develops under certain conditions between air originating in polar regions and air from low latitudes. A large number of depressions in temperate latitudes develop on the polar front.

**Polar Maritime Air.** An unstable air mass with low temperature and high humidity which originated in the polar regions, and has become saturated during its passage over the warmer sea.

**Polaris.** See NORTH STAR.

**Polarization.** The deposition of hydrogen on the positive plate of a primary cell.

**Poles.** See GEOGRAPHICAL POLES; MAGNETIC POLES.

**Polyconic Projections.** Polyconic projections are constructed on the principle of projecting the surface of the earth on a series of cones which touch its surface along successive parallels of latitude.

The centre meridian is always a vertical centre line of the map. The other meridians and all parallels of latitude are curved lines which meet at right angles.

This gives a certain amount of distortion east and west, but is fairly accurate north and south.

**Pontoon.** A term, now obsolete, which was used when referring to the float of a seaplane.

**Poppet Valve.** See ENGINE VALVES.

**Porpoise.** An undulatory movement of a seaplane about its lateral axis which occurs at certain speeds when taxi-ing.

**Port.** The left-hand side of an aircraft or ship as seen by an observer looking ahead.

**Port Drift Angle.** When the track of the aircraft is to port, this is the angle between the longitudinal axis of the aircraft and its track.

**Portlights.** Portholes or scuttles in a hull to admit entry of light and air to the interior of a hull.

**Positive Displacement Supercharger.** A supercharger in which either air or air/fuel mixture is delivered under compression to the engine in pulsations. When the supercharger is at rest the mixture cannot flow back through the supercharger as it might in the centrifugal type.

**Positive-driven-type Supercharger.** A supercharger which is driven from the engine shaft by gears.

**Potential Energy.** The energy due

to the relative position of one body to another or of a part of a body to another part of the same body when under the action of force trying to alter their positions.

**Potentiometer.** An electrical instrument which measures the voltage drop in any part of an electrical system.

**Power.** A measure of the amount of work which can be done in a given time.

**Power Loading.** The "all-up" or flying weight of an aeroplane divided by the rated horse-power of the engine or engines.

**Power Press.** A term applied to many kinds of presses but generally referring to a press in which the power is delivered by a vertical ram.

**P.R.** Letters used to denote photographic reconnaissance aircraft. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Spitfire P.R. XI.

**Pratt Truss.** A construction sometimes called an N truss. The bracing is composed of vertical and diagonal members alternately.

**Precipitation.** A name for the forms in which water may fall after condensation from the atmosphere such as rain, snow, hail, and sleet. Precipitation occurs when a greater amount of moisture exists in the atmosphere than can be absorbed at the saturation point.

**Precision Castings.** See DIE CASTING.

**Predictor.** A mechanism which indicates the direction, height, and speed at which an aircraft is flying and gives the anti-aircraft gun crew the necessary information to sight and fire the gun.

**Pref-ignition.** This term is used to indicate that the fuel/air mixture in the cylinder of an internal combustion engine has been ignited by means other than the sparking plug. It is normally caused by white-hot

carbon particles which have been deposited in the combustion chamber. The fuel/air mixture is therefore ignited before its correct time. This causes the internal parts of an engine to be damaged. If pre-ignition once commences, the engine may continue to fire after the ignition system has been switched off.

**Press Fit.** A fit which is required to be solid. The assembly is accomplished by forcing one part into the other, and is also known as an interference fit.

**Pressure.** See ATMOSPHERIC PRESSURE; BAROMETRIC PRESSURE; BOOST PRESSURE; MAXIMUM PERMISSIBLE BOOST PRESSURE; RATED BOOST PRESSURE.

**Pressure Gauges.** Pressure gauges are necessary for indicating the pressure in a system in lb. per sq. in. They are normally constructed on the principle of a Bourdon pressure tube.

**Pressure Gradient.** The rate of change of barometric pressure per unit of horizontal distance in a direction normal to the isobars on a weather chart.

**Pressure Head.** A combination of pitot and static pressure tubes. It is used in conjunction with a pressure gauge for determining the speed of flight.

**Pressure Height.** The altitude at which the envelope or gasbags of an aerostat are just full, when the pressure is atmospheric at the bottom of the envelope or bag.

**Pressure Pump.** A pump which supplies any liquid under pressure, e.g. the oil pump is a pressure pump.

**Prevailing Winds.** Winds which blow for the greater part of the year from one direction in any particular district.

**Primary Cell.** A type of cell which cannot be recharged in the normal manner (electrically), though renewal is possible by replacement

of the electrodes and the electrolyte. It is a source of e.m.f. consisting of two electrodes immersed in a chemical solution.

**Prime Meridian.** A meridian which has been selected as an international point of reference. The one most used is the meridian which passes through the Royal Observatory at Greenwich.

**Primer.** A mechanical means which supplies fuel to the induction pipe or to the combustion chamber to facilitate the starting of an internal combustion engine.

**Princess Mary's R.A.F. Nursing Service.** See ROYAL AIR FORCE NURSING SERVICE.

**Private Aeroplane.** An aeroplane which is not used for commercial or industrial purposes.

**Private Pilot's Licence.** This is one of the Pilots' Licences (Aeroplane), and is known as a Class "A" Licence. It is issued to individuals who wish to fly for pleasure or for their own business purposes.

The holder may fly any type of aircraft in almost any country, and it allows him to carry passengers and goods, providing he does so without charge or personal remuneration.

This licence may be issued to either sex and any nationality, but applicants must fulfil the following conditions—

(a) Have attained the age of 17 years.

(b) Produce a doctor's certificate of physical fitness.

(c) Have flown at least three hours as a sole occupant of an aircraft; and

(d) Pass two tests of practical flying ability and an oral examination of technical subjects.

**Profile.** The contour of an object as seen from the side.

**Profile Drag.** This is the difference between the total wing drag and the induced drag, and is the sum of

the surface friction and form drag. Profile drag varies very little with alterations of the angle of attack.

**Prohibited Areas.** In the interest of public safety and for military reasons, the flying over certain areas is prohibited by law. The positions of these areas are marked on maps.

**Prony Brake.** This is the simplest form of absorption dynamometer. It consists of a brake drum and a brake with a torque arm carrying a weight. When the engine is running at the desired speed the brake is applied and the weights adjusted so that the torque arm is stationary. From the information obtained the horse-power can be computed.

**Proof Stress.** This is the load under which a material must not stretch permanently beyond a specified percentage of the length under test.

**Proofing.** A term used to denote the treatment of fabric to make it gastight and/or weather resisting.

**Propeller.** A device for propelling a craft through a fluid. It includes all types of screws with helical blades. Propellers are power driven and designed to produce thrust by rotation. There are various types, such as fixed pitch, variable pitch, and constant speed.

Some types are capable of being fully feathered, i.e. blades can be turned beyond the coarse pitch until they lie in planes approximately parallel to the longitudinal axis of the aircraft, thus preventing an engine which has been cut-out from being rotated by the air. This reduces drag; also it eliminates further damage to a faulty engine, by allowing it to come to rest in the air.

Propellers are made (a) entirely of wood; (b) of specially impregnated and compressed wood blades with metal bosses; (c) of aluminium alloy; and (d) of steel. The latter have hollow blades.

The variable pitch type has generally two blade positions, viz. fine and coarse, and is manually operated. The constant speed type controls the engine revolutions by altering the load on the engine and is automatic in operation. Thus, if the engine tends to speed up, the angle of the blades is coarsened, and vice versa. Control is by a centrifugal-governor which operates a valve and admits high pressure oil to the appropriate side of a piston, thus actuating the blades. Another type is electrically operated.

**Propeller Boss.** The central section of an all-wood propeller to which the metal hub is fitted.

**Propeller, Constant Speed.** See CONSTANT SPEED PROPELLER.

**Propeller Diameter.** The diameter of the circle described by the tips of the propeller blades.

**Propeller Dynamic Balance.** See DYNAMIC BALANCE.

**Propeller Efficiency.** The ratio of the thrust horse-power developed to the horse-power put into a propeller. The value of the variable pitch propeller lies in the fact that by altering the blade angles to suit conditions the efficiency is maintained at its best value.

**Propeller Hub.** That part of a propeller assembly which is between the engine extension shaft and the propeller boss.

**Propeller, Left-hand.** See LEFT-HAND PROPELLER.

**Propeller (Out of Alignment).** When the sweep of one blade is in a different plane from that of the other blade or blades.

**Propeller, Pusher.** See PUSHER PROPELLER.

**Propeller, Right-hand.** See RIGHT-HAND PROPELLER.

**Propeller Section.** A cross-section of a propeller blade at any point parallel to the axis of rotation of the propeller. The shape of such a section is that of an aerofoil.

**Propeller Slip.** Propeller blades are set at a certain pitch angle which may be compared with the pitch angle of a screw thread on a bolt. It is clear that in the case of a single-start thread a nut would move an axial distance along the bolt equal to the pitch when the nut is rotated once. On the other hand, owing to the non-dense medium in which it works, a propeller blade under load does not move forward a distance equal to its geometrical pitch each revolution.

Hence the ratio of the actual advance per revolution of the propeller under specified conditions to the advance per revolution of the propeller when no thrust is being produced is known as the percentage slip.

**Propeller Static Balance.** Owing to the magnitude of the centrifugal forces set up in the material of a propeller in operation, it is essential that it is properly balanced, both statically and dynamically. To test for static balance, the propeller is mounted on a spindle placed on two parallel level knife edges. To be in balance it should remain at rest in all rotational positions, i.e. the sum of the moments of all its parts about the axis of rotation must be zero.

See also DYNAMIC BALANCE.

**Propeller, Swivelling.** See SWIVELLING PROPELLER.

**Propeller Thrust.** The component of the resultant air force on the propeller blades which is parallel to the axis of the propeller.

**Propeller Torque.** The total drag of the propeller blades which causes a turning moment or torque and which opposes the engine torque. This propeller torque tends to rotate the aeroplane in an opposite rotation to that of the propeller.

It is a simple matter to measure the brake horse-power of an engine



by measuring the propeller torque by means of a reaction type dynamometer.

**Propeller, Tractor.** See TRACTOR PROPELLER.

**Propeller, Variable Pitch.** See VARIABLE PITCH PROPELLER.

**Proton.** A particle of positive electricity.

**Prototype.** The first aeroplane of a new type to be built.

**Psychrometer.** An alternative name for a wet and dry bulb hygrometer, an instrument for measuring atmospheric humidity.

**Pterodactyl.** A type of aeroplane without a tail. It has a short fuselage and no elevators, fin, or rudder at the rear. The wings are swept back to a considerable degree and have the control surfaces at the wing tips. The tips of the swept-back wings are behind the centre of gravity so that the movable surfaces act as an elevator.

**Pull-off.** A method of starting a parachute descent. The jumper takes up his position on the rear of the wing and pulls the rip-cord of the parachute. This opens the parachute and he is pulled off the wing. This type of descent is usually from a biplane.

**Pull-out.** The manoeuvre of changing the direction of an aeroplane from a dive to horizontal flight or climbing flight.

**Pumps.** See PRESSURE PUMP; SCAVENGE PUMP.

**Pure Dry Air.** A mixture which consists of approximately 78 per cent nitrogen, 21 per cent oxygen,

1 per cent argon, and 0.03 per cent carbon dioxide, and is free from water vapour.

**Purity.** A term used to denote the percentage of pure gas in a given volume of gas in an aerostat.

**Push Fit.** A push fit is one which requires a moderate pressure for assembly. The clearance allowed varies from a low limit of 0.00045 in. to a high limit of 0.00075 in., the assembled parts being fixed in one position.

The variation of the clearance allowed is dependent upon the size of parts and the metal used.

**Pusher Aeroplane.** An aeroplane in which the main planes are in front of the propeller.

**Pusher Engine.** An engine which is fitted with a pusher propeller.

**Pusher Propeller.** A propeller which is fitted behind the main supporting planes or, alternatively, a propeller which is fitted in the rear of the engine. Such propellers "push" the engines before them.

**Pylon.** The structure of an autogiro which supports the rotor. The term is also used for a built-up vertical structure with defined markings for use at air races.

See also CABANE.

**Pyrometer.** An electrical thermometer which uses the principle of the electric thermo-couple. The source of heat generates an electric current in the thermo-couple, and the result is measured on a galvanometer which is calibrated in degrees.

See also THERMO-COUPLE.

## Q

**Qibli.** A hot, dry, southerly wind which occurs in Tripoli. It is similar to the Sirocco which occurs in the Mediterranean.

**Quadrant Sight.** A sight used for determining the point of impact of a bomb. Two sights are normally used, one at each end of a base line of known length. They are employed on the ground.

**Quadrantal Points.** North-east; south-west; south-east; north-west.

**Quadruplane.** An aeroplane which

has four main supporting surfaces one above the other.

**Quenching.** The act of cooling metal objects in water, oil, or other medium. When quenched at the correct temperature the desired characteristics of the metal or alloy are obtained.

**Quick Release.** A mechanical device used on a parachute which enables the user to clear himself quickly from the parachute and/or the harness.

## R

**Radar.** Equipment used to estimate Range And Direction And Recognition.

**Radial Engine.** An engine having cylinders which are stationary and are arranged radially around a common crankshaft.

**Radial Wiring.** A system of wires in an aerostat which connects the joints of the transverse frame to the central fitting.

**Radian.** That angle at the centre of a circle which is made by an arc of that circle whose length is equal to the radius of the circle.

$$\text{One radian} = \frac{180^\circ}{3.1416} = 57.2958^\circ$$

**Radiation Fogs and Morning Mists.** These fogs usually occur on calm, cloudless nights.

They are caused by the vapour produced by the heat of the day making contact with the cold surface of the earth.

**Radiator Header Tank.** That portion of a radiator in which the cooling liquid is collected from the engine and returned to the cooling elements.

**Radiator Shutter.** A device which regulates the temperature of the cooling liquid of an internal combustion engine by controlling the flow of air through the radiator.

**Radiator Vent Pipe.** An open-ended pipe fitted in the liquid cooling system from the air space in the header tank to the atmosphere.

**Radiators.** See HONEYCOMB RADIATOR; LEADING EDGE RADIATOR; NOSE PIECE RADIATOR; RETRACTABLE RADIATOR; UNDER-SLUNG RADIATOR; WING RADIATOR.

**Radio.** This term is used in its broadest sense as an inclusive term for all uses of wireless.

**Radio Direction Finding.** Nor-

mally referred to as R.D.F. It covers all methods of radiolocation involving reflection or re-radiation.

See also RADAR.

**Radius of Action.** Half the maximum distance an aircraft can travel in still air without refuelling, that is, the maximum distance it can travel in a straight line in still air and return to its base.

**Radius of the Earth.** The radius of the earth to the Equator is 3963.34 statute miles, and the radius to the Poles is 3949.99 statute miles.

**R.A.F.** See ROYAL AIR FORCE.

**Rain.** Precipitation of water drops after condensation from the atmosphere.

**Rain Gauge.** An instrument for measuring rainfall. The total rainfall for a given time is collected in a container of reasonably large size, and then poured into a small vertical calibrated tube.

**Rainbow.** A luminous arc which is formed by the refraction of sunlight by drops of water suspended in the atmosphere.

**Range.** The maximum distance an aircraft can travel without having to refuel. Conditions must be specified because head winds reduce the range and following winds increase it.

**Range at Economic Speed.** The maximum distance a given aircraft can cover while cruising at the most economical speed and altitude during all stages of the flight.

**Range at Full Speed.** The maximum distance a given aircraft can cover at full speed at sea level.

**Ranks of the Royal Air Force.** Marshal of the Royal Air Force; Air Chief Marshal; Air Marshal; Air Vice-Marshal; Air Commodore; Group Captain; Wing Commander;

Squadron Leader; Flight Lieutenant; Flying Officer; Pilot Officer; Warrant Officer; Flight Sergeant; Sergeant; Corporal.

**Ranks of the Women's Auxiliary Air Force.** Air Chief Commandant; Air Commandant; Group Officer; Wing Officer; Squadron Officer; Flight Officer; Section Officer; Assistant Section Officer; Warrant Officer; Flight Sergeant; Sergeant; Corporal.

**Rate of Climb.** The vertical velocity of an aircraft, with reference to the air, i.e. the rate of ascent from the ground. In performance testing it is corrected to standard atmosphere.

**Rate of Climb Indicator.** An instrument indicating in feet per minute the rate of climb or descent of an aircraft. The latest type indicators are extremely accurate and are sensitive to small changes of altitude.

**Rate of Side-slip.** See LATERAL VELOCITY.

**Rated Altitude.** The lowest altitude at which it is permissible to use full throttle at normal revolutions per minute. In the case of a supercharged engine it is also the highest altitude at which the rated boost pressure can be sustained at normal revolutions per minute. The international power rating of an aero engine is measured at this altitude.

**Rated Boost Pressure.** The boost pressure which is obtained when an engine is set at full throttle and running at normal revolutions per minute at the rated altitude under standard atmospheric conditions.

**Rated Horse-power.** The brake horse-power developed by an engine when operating at full throttle and normal r.p.m. at the rated altitude in standard atmosphere.

**Ray.** The path along which light and electromagnetic waves travel in space.

**Reaction.** See NEWTON'S LAWS OF MOTION.

**Recalescence Point.** This is the temperature at which, when steel is cooling, the carbides are precipitated. Recalescence is accompanied by a slight rise of temperature.

**Reciprocal Bearing.** A bearing in the opposite direction to the original bearing. It is found by adding  $180^\circ$  to or subtracting  $180^\circ$  from the observed bearing.

**Reciprocating Type Supercharger.** A pump in which the air or fuel/air mixture is compressed by a piston working in a special cylinder before delivering it to the manifold.

**Reconnaissance.** An observation which may be carried out by aircraft to obtain information regarding the enemy's defences, etc.

**Recording Accelerometer.** An instrument which measures and records the acceleration of an aircraft in a defined direction.

**Recording Altimeter.** This particular type of altitude recorder is used on aeroplanes to record continuously the altitude on a time base chart. It consists essentially of a drum carrying a roll of suitably marked squared paper and rotated by clockwork. Actuated by the aneroid through suitable mechanism is an autographic device which marks the paper as the drum revolves, thus drawing an altitude-time graph. These instruments can be sealed and are suitable for checking altitude records, rate of climb, etc.

See also BAROGRAPH.

**Red Brass.** A copper alloy used for pipes and tubes which are subject to corrosion by the action of sea water. It contains about 85 per cent copper and 15 per cent zinc.

**Refining Crude Oil.** The refining process is designed to eliminate the undesirable constituents without damage to the paraffin constituents,

as the paraffin hydrocarbons are most desirable in lubricating oil. Two methods of refining are commonly used, the acid extraction and the solvent extraction.

**Refraction.** The change in the apparent position or size of a body due to the water drops in the atmosphere or to air at different density.

**Refrigerated Wind Tunnel.** A wind tunnel in which a refrigerator is incorporated. Ice-forming conditions similar to those met with in flight can be produced and the effect studied.

**Registering Balloon.** A small free balloon which carries self-recording instruments into the upper air to obtain the pressure, temperature, and humidity at varying heights.

**Registration Marks.** The nationality and registration marks must be clearly visible on all aircraft engaged in international navigation. They consist of a group of five letters. The first or first two letters indicate the nationality of the aircraft, followed immediately by a hyphen, after which the registration letters are placed.

**Registration of Aircraft.** The registration of aircraft is made in accordance with laws and special provisions of each State. No aircraft can be registered in more than one State. A register is kept in all countries and the following particulars are recorded—

- (a) Description of the aircraft.
- (b) The number and other identification marks given to it by the maker.
- (c) The nationality and registration marks.
- (d) The usual station of the aircraft.
- (e) The full name, nationality, and residence of the owner.
- (f) The date of registration.

**Relative Humidity.** The ratio of moisture actually present in a given

volume of air to the amount present in an equal volume of saturated air at the same temperature.

**Relative Wind.** The velocity and direction of the air movement with reference to a body in the air-stream.

**Relief Map.** A map which shows the height or depth above or below sea level of hills or valleys by line shadings or by colour.

**Reserve Water Tank.** A tank which is placed at the highest point of a cooling system for reserve water.

**Reshabar.** A strong, squally wind of a dry nature which blows down certain mountain ranges in Southern Kurdistan from a north-easterly direction.

**Residual Magnetism.** The magnetism which remains in a metal after the magnetizing force has been taken away.

**Resilience.** The term given to the work done in producing stress in a body within its elastic limits or the work done in regaining its original form.

**Resin.** A term applied to various vegetable and mineral substances which may be solid or semi-solid. Synthetic resin can be obtained from coal-tar. Resins are soluble in alcohol, ether, and liquid hydrocarbons.

See also PLASTICS.

**Resistance Welding.** A method of joining two sheets of metal together by the passing of an electric current through the metals. The resistance at the joint of the metal causes a rapid heating and results in a local fusion of the metal.

**Restoring Moment.** A moment which tends to restore to its previous position an aircraft after any disturbance from normal steady flight.

**Resultant Force.** A force which, if acting on its own, would produce

the same result as several forces acting together.

**Retractable Landing Gear.** A normal type of alighting gear which is retracted into the body or wings of an aeroplane in order to reduce the drag. The mechanism may be operated hydraulically, electrically, or by hand.

**Retractable Radiator.** A liquid-cooled radiator which is capable of being withdrawn from the airflow into the fuselage or other part of the airframe.

**Return Flow Wind Tunnel.** A wind tunnel in which the fluid stream after passing through the tunnel and fan is returned through another passage, generally of gradually increasing area, to the entrance of the tunnel.

**Reversal.** In meteorology this is a change of more than 90° in direction between the wind on the surface of the earth and the wind in the upper air.

**Revolution Indicator.** An indicator which is used for showing the revolutions per minute of the crankshaft or other rotating part. They are of mechanical or electrical type. Sometimes called a tachometer.

**Reynolds' Number.** This is a correction factor which takes into account the dimensions of the model and the speed at which a test is run. It also allows for the increasing density of the air in the wind tunnel. This is necessary in order that the results of the tests will be comparable with those that would be obtained if the tests were run with real aircraft and at normal flying speeds.

Reynolds' number is the ratio of the product of any typical length and velocity of a body to the kinematic coefficient of viscosity of a fluid.

**R.F.C.** See ROYAL FLYING CORPS.

**Rhumb Line.** A line on a map which has the same compass bearing

and which crosses all meridians at the same angle.

**Rib.** A member of an aeroplane structure which gives the specific external shape or contour to the covering material of planes, control surfaces, etc. Ribs are used to aid in giving the necessary rigidity and maintain the shape under load.

**Ridge.** A relatively narrow extension between a col and an anticyclone on a weather chart.

**Riding Lamps.** Lamps which must be displayed by aircraft when at anchor or when moored.

**Riding Lights.** See RIDING LAMPS.

**Rigger.** A person who is skilled in the assembling and adjustment of the component parts of an airframe.

**Rigging.** In aerodynes this is the adjustment or alignment of the different components in their correct position. In aerostats it is the system of wires or cords by which the weight of certain parts of an aerostat is distributed over the envelope.

**Rigging Band.** A reinforced band round the envelope of an aerostat for the attachment of rigging.

**Rigging Datum Line.** An arbitrary line which is made horizontal on an aeroplane for the purpose of rigging and truing the aeroplane.

**Rigging Lines.** In a parachute these are the cords which transmit the load from the harness to the canopy.

**Rigging Position.** The position of an aeroplane with the manufacturer's arbitrary longitudinal datum line horizontal and with the lateral axis also horizontal.

It is necessary to place an aeroplane in this position in order to adjust the main planes, tail planes, etc.

**Right-hand Engine.** An engine whose propeller shaft rotates in a clockwise direction to an observer

looking at the propeller with the engine between the propeller and observer.

**Right-hand Magneto.** A magneto which is revolving in a clockwise direction to an observer who is looking at the driving end.

**Right-hand Propeller.** A propeller which revolves in a clockwise direction to an observer behind the aircraft.

**Rigid Airship.** An airship which has a metal framework to maintain the envelope in shape. It has transverse frames of light metal connected by longitudinal members braced by steel wires.

**Rime.** A white, opaque ice of a feathery nature which forms along the leading edges of wings and control surfaces. It forms on the windward side of exposed objects when frost and wet fog occur at the same time.

**Ring Cowling.** See TOWNEND RING.

**Ring Gauge.** A circular type precision gauge used for measuring the diameter of cylindrical objects. It may be a plain ring gauge or of the threaded type.

**Rip Cord.** A hand-operated cord which releases a free parachute from the pack.

**Ripping Line.** A cord or rope which can be used for tearing open the ripping panel of an aerostat.

See also RIPPING PANEL.

**Ripping Panel.** A strip of fabric that can be easily torn open for rapid deflation of an aerostat.

**Rivet Gun.** A pneumatic riveter which is portable and is commonly used for the manufacture of aircraft components.

**Rivet Set.** A small tool shaped at one end to form a specific contour when a rivet is headed.

**Riveting Machine.** A machine in which a plunger fits either the head or the shank of a rivet. The operation of riveting is carried out by

compression between this plunger and an anvil.

**R.N.A.S.** See ROYAL NAVAL AIR SERVICE.

**Roaks.** A term which denotes blow-holes in steel caused by carbon monoxide. These blow-holes do not weld up during subsequent working of the metal, and generally appear as elongated cracks.

**Roaring Forties.** A term used to denote the prevailing westerly winds over the oceans of the southern hemisphere, south of latitude 40° S.

**Rocket Propulsion.** A type of jet propulsion in which the propulsive jet is produced by the burning of an explosive charge which relies entirely for its combustion on the oxygen chemically combined in the charge, and hence has a range limited by the weight of charge carried. This system has been applied to the problem of assisted take-off.

**Rockwell Hardness Test.** A hardness test which is based upon the additional depth to which a hardened steel ball can be driven by a major load beyond the depth to which the same ball can be driven by a known minor load. The minor load is first applied and then the major load. The hardness number is indicated on a dial.

**Roll.** A complete angular revolution about the longitudinal axis, the horizontal direction of flight being maintained.

**Roller Bearing.** A bearing which utilizes hardened steel rollers. These rollers are located between an outer and an inner race.

**Rolling.** A lateral motion about the longitudinal axis of an aeroplane.

See also ROLL.

**Rolling Balance.** A balance which has been designed for measuring aerodynamic forces whilst the model is rotating about an axis parallel to the direction of the airflow.

**Rolling Instability.** This is a type of lateral instability in which an aircraft increases its oscillation after a rolling disturbance, and does not return to a horizontal position.

**Roots-type Supercharger.** A rotary blower consisting of two double-bladed impellers turning in opposite directions on parallel shafts. Incoming air or mixture is trapped between the ends of the housing and swept through to the outlet by the impellers.

**Rotary Engine.** An engine having cylinders arranged radially around a common fixed crankshaft, the cylinders revolving.

**Rotary Jet Cooler.** A type of oil cooler in which rotating jets of oil impinge on a cooled metal surface.

**Rotor Plane.** A form of aircraft from which the support in the air is derived by rotating aerofoils.

**Royal Aero Club.** This club, whose full title is the Royal Aero Club of the United Kingdom, has for its objects the development and encouragement of the study of aeronautics. It also provides a centre of information and advice on aeronautical subjects, and controls all competitions, sporting events, trials, etc., in the United Kingdom. Its address is 119 Piccadilly, London, W.1.

**Royal Aero Club Certificate.** A certificate issued by the Royal Aero Club of the United Kingdom to individuals who pass a prescribed pilotage test on a heavier-than-air aircraft. It is issued under the regulations of the International Aeronautical Federation. It is accepted by the Air Ministry as equal to the Class "A" Pilot's Licence. It remains valid for life and is recognized in most countries, but does not comply with British civil regulations. The "A" Licence must be obtained.

**Royal Aeronautical Society.** This is the oldest aeronautical institution

in the world. In October, 1927, the Institution of Aeronautical Engineers was amalgamated with the Royal Aeronautical Society.

The address of this society is 4 Hamilton Place, London, W.1.

**Royal Air Force.** The Royal Air Force is one of the fighting Services of the Crown. It works in co-operation with the other Services and its functions come under the following headings—

- (a) Bombing.
- (b) Air fighting.
- (c) Co-operation with the Army.
- (d) Co-operation with the Navy.

It consists of the regular, reserve, and auxiliary air forces. It is divided into Commands, which are again subdivided into Groups, Stations, and Units.

**Royal Air Force Benevolent Fund.** This fund was established as the Royal Air Force Memorial Fund in October, 1919. The name was later changed to the Royal Air Force Benevolent Fund. It was established to commemorate the work of the flying services during the war 1914-18. The fund is for the relief of distress amongst all ranks of the Royal Air Force and their dependants.

In 1939, the scope was extended to permit assistance being given to personnel of the Auxiliary Air Force, R.A.F. Reserve, and the Women's Auxiliary Air Force.

At Vanbrugh Castle School, Blackheath, the sons of airmen are accepted for educational training. This school was opened in August, 1921. In addition, educational grants are made to the sons and daughters of officers of the Royal Air Force, both past and present. The offices of the Fund are at 14 Eaton Road, Hove, Sussex (temporary address).

**Royal Air Force Ensign.** The ensign is of a light blue background with the Union Jack in the first



quarter and in the centre of the fly half of the flag three roundels superimposed red upon white upon blue.

**Royal Air Force Memorial.** This memorial was erected on the Whitehall Stairs, Victoria Embankment, and is a memorial to the officers and men of the flying services who fell in the war 1914-18.

**Royal Air Force Memorial Fund.** See ROYAL AIR FORCE BENEVOLENT FUND.

**Royal Air Force Nursing Service.** This service was formed in June, 1918, as a war measure to meet the needs of the R.A.F. It is now a permanent branch of the R.A.F., and was established under Royal Warrant on the 27th January, 1921.

In June, 1933, it was designated by Royal consent as Princess Mary's Royal Air Force Nursing Service.

**Royal Air Mail Pennant.** A pennant used on aircraft under contract to the Post Office. It has a deep blue background with a yellow device of a post horn surmounted by a crown. Around this are the words "Royal Air Mail" in white letters.

**Royal Flying Corps.** In 1878, experiments were carried out at Woolwich Arsenal with free and captive balloons, and later the Royal Engineers were trained to manage them. In 1884, in Bechuanaland and the Sudan, and in 1899, in South Africa, balloon sections were with the forces. In February, 1911, a formation of the Royal Engineers was authorized as the Air Battalion. On the 13th May, 1912, the Royal Flying Corps was formed. This consisted of a naval wing, a military wing, a Central Flying School, and the aircraft factory.

The strength of the Royal Flying Corps on the outbreak of the war, 1914-18, was 179 aeroplanes with 147 officers and 1097 other ranks. The Royal Flying Corps and Royal Naval Air Service were fused into

the Royal Air Force on 1st April, 1918.

**Royal Naval Air Service.** In March, 1911, the Royal Navy began its first organized flying at Eastchurch, and in May, 1912, it became the Naval Wing of the Royal Flying Corps (q.v.), and succeeded in flying off and alighting on water. In 1912, flying off the decks of ships was accomplished. In July, 1914, the Naval Wing was detached from the Royal Flying Corps and became the Royal Naval Air Service. The Royal Naval Air Service was responsible for the development of the airship in addition to the aeroplane requirements of the Royal Navy. The Royal Naval Air Service and the Royal Flying Corps were fused into the Royal Air Force on 1st April, 1918.

**R.P.** Letters used to denote rocket projectile aircraft. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Beaufighter R.P.X.

**Rudder.** A movable vertical aerofoil usually fitted at the after end of the fuselage of an aircraft, the function of which is to control the motion of an aerodyne in yaw.

**Rudder Angle.** The angle between the chord of the rudder and the chord of the aerofoil to which it is hinged.

**Rudder Bar.** A bar by means of which the control cables leading to the rudder are operated by the feet.

**Rudder Control Cables.** These are the cables which connect the rudder bar to the rudder.

**Rudder Lever.** The lever which connects the actuating mechanism to the rudder.

**Rudder Pedals.** A device which is used as an alternative to a rudder bar.

**Rudder Post.** The principal vertical member of the fin to which are attached the rudder hinges.

**Running Fit.** This term is applied to mated parts that revolve or move freely after being assembled. The clearances vary according to the size of shafts and materials employed in their manufacture.

**Running In.** The running of an engine at various throttle settings for a stated period of time after the first assembly or after the

overhaul or major repair of an engine.

**Running Rigging.** A type of rigging used on a kite balloon which adjusts itself automatically to a change of direction or pull.

**Runway.** A hard-surface landing strip which permits the landing and take-off of aeroplanes under all weather conditions.

## S

**Safety Belt.** A belt or strap which secures the pilot or passenger safely in his seat.

**Safety Pin.** A device designed to prevent a bomb being accidentally rendered dangerous. Sometimes called a safety clip.

**Sagging.** The tendency of a hull to drop at the centre or amidships when that part is insufficiently supported. The opposite of hogging.

**Sailplane.** An aerodyne without a power plant which is used for free flight. By taking advantage of air currents it is capable of continuous flight.

**Sand Blasting.** A jet of sand at high velocity which is projected against a metal surface to clean off the scale.

**Sand Casting.** A casting made by pouring the molten metal in a sand mould. Sand moulds are often a necessity for large or intricate cored castings. Because of the higher cost of permanent moulds, sand moulds are used for small quantities.

**Sand Pillar.** See DUST DEVIL.

**Sand Storm.** A strong wind which usually occurs in the desert and carries dust or sand extending over a considerable area.

**Saturated Adiabatic Lapse Rate.** The rate of decrease of temperature of saturated air under adiabatic conditions. The value of this lapse rate depends upon the prevailing temperature. At 50° F. it is approximately 3° F. for 1000 ft. (or at 10° C. it is 0.6° C. for 100 metres).

**Saturation.** The condition which exists in the atmosphere when the pressure exerted by the water vapour in the air is equal to the maximum vapour pressure at the existing temperature. It is the condition when no more moisture

can be held in suspension in the air at the existing temperature.

**Saturation Point.** The maximum amount of moisture that the atmosphere will hold at a given temperature. With increased temperature the amount of moisture which can be held in suspension in the atmosphere increases rapidly.

**Sausage.** A term applied to the conical streamer used on airfields to indicate the direction of the wind.

**Scale Effect.** The effect upon the absolute coefficients of an alteration in the Reynolds' number ( $q.v.$ ).

**Scale of Visibility.** See APPENDIX B.

**Scarf Joint.** A spliced and glued wood joint. The two portions to be joined have a slope of one inch in ten inches for aircraft repairs. This joint is used for the repairing of stressed parts such as longerons in composite or wood aeroplanes.

**Scavenge Pipe.** A return oil pipe which leads the hot lubricating oil from the engine to the oil tank.

**Scavenge Pump.** A pump which withdraws the hot lubricating oil from the sump and returns it to the oil tank.

**Schneider Seaplane Trophy.** A trophy presented to the Aero Club of France in 1913 by M. Jacques Schneider, for the highest speed attained by a seaplane. In 1913 it was won by M. Prévost for France at a speed of 45.75 miles per hour. It was won outright in 1931 for Great Britain by Flight-Lieutenant J. N. Boothman at a speed of 340.08 miles per hour.

**Scoop Type Air Intake.** An air intake shaped like a scoop and directed forward which increases the pressure of the air to the carburettor.

**Scraper Ring.** A spring ring similar to a piston ring which

removes superfluous oil from the cylinder wall.

**Screened Ignition Cables.** High tension and low tension cables which are provided with a metal sheathing, the sheathing being usually of braided copper wire.

See also SCREENING.

**Screened Sparking Plug.** A sparking plug which is completely enveloped in a screen of metal, this screen being connected to the earth system of the engine.

See also SCREENING.

**Screening.** A metal covering which surrounds the high tension and low tension parts of the ignition system or other electrical systems. This screening prevents interference between the ignition system and the radio equipment.

**Screw Pitch Gauge.** A gauge used to determine the pitch of a given screw thread. The most common type of screw pitch gauge is a series of flat steel strips of metal having slotted vee sections, each strip cut to a given pitch.

**Scribe Board.** Special board on which the lines of a hull or float in transverse section are marked out before construction, and from which various dimensions required are obtained.

**Scud.** Small masses of cloud which are moving rapidly below the solid clouds.

**Scuttles.** See PORTLIGHTS.

**Sea Anchor.** See DROGUE.

**Sea Breeze.** A wind which blows towards the land and which occurs during the day. It is caused by the more rapid heating of air over the land than over the water.

**Sea Disturbance.** The movement of the sea which is produced locally by the wind.

**Sea Fog.** Fog which is formed at sea. It is generally due to condensation of moisture in the lower layers of a warm air current which passes over a comparatively cold sea surface.

**Sea Fret.** This is a colloquial term used in Eastern England for a sea fog.

**Sea Marker.** A device (for determining the drift angle) which is dropped from an aircraft on to water and thus provides a distinguishable patch.

**Seadrome.** A floating airport anchored at sea for the operation of aeroplanes.

**Sea-level Horse-power.** The brake horse-power which is developed at normal revolutions per minute and at standard sea-level conditions by—

(a) Normally aspirated engines at full throttle;

(b) Supercharged engines at the rated boost pressure; and

(c) Super-compression engines at the predetermined limit of throttle opening.

Standard sea-level conditions are 760 mm. and 15° C.

**Seam Weld.** A seam which is welded by the overlapping of a number of spot welds.

**Seaplane.** An aeroplane which is designed to rise from and alight on the water in a normal way. This term refers to both boat and float types. The boat type is known as a flying boat, and the float type as a float seaplane.

**Seaplane Air Intake.** An air intake to the carburettor which has a raised entry to minimize the entry of sea spray, very similar to a desert type air intake.

**Seaplane Hull.** The main structural part of a flying boat or boat amphibian which gives buoyancy when on the surface of the water. It has the necessary accommodation for the crew and passengers.

**Seat Type Parachute.** A parachute which is attached to the wearer in such a manner as to form a cushion or seat.

**Secondary Cold Front.** A small cold front which follows the larger

primary cold front of a polar air mass.

**Secondary Depression.** A small area of low pressure on the border of a large or primary one. The secondary may develop while the primary centre disappears.

**Secondary Winding.** The output winding of a transformer in which an e.m.f. is induced from the primary winding.

**Secretary of State for Air.** A Cabinet Minister who is also the President of the Air Council.

**Section Officer.** The equivalent commissioned rank in the Women's Auxiliary Air Force to that of a Pilot Officer in the Royal Air Force.

**Segregation.** This refers to the separating of carbon, sulphur, phosphorus, etc., when cooling molten steel. By reheating the carbon can be redistributed.

**Seistan Wind.** A strong northerly wind in the province of Seistan, Eastern Persia, occurring in summer. It continues for about four months and is known as the wind of 120 days.

**Selective Fits.** Fits which are made from parts which are not of standard dimensions, and where the correct desired fit must be obtained by hand selection. Selective fits should be used as little as possible because the parts are not interchangeable.

**Selsyn.** This is a coil which is placed in a pulsating magnetic field. At the terminals of the coil an alternating voltage is generated whose magnitude is a function of the position of the coil with respect to the axis of the field. When the coil is so placed as to link maximum flux, the voltage is at a maximum. If the coil is rotated in either direction the voltage drops until at 90° it becomes zero. If the coil is rotated through another 90° a change in polarity of the voltage occurs.

**Semi-cantilever Beam.** A beam which is only partially cantilevered and is aided by external bracing to carry the necessary load.

**Semi-rigid Airship.** An airship similar to the non-rigid but having a keel which stiffens the envelope and takes the loads carried by the airship. Nose stiffeners are sometimes built up from the keel.

**Semi-span.** The distance from the tip of a wing to the longitudinal datum line.

**Separation.** See BURBLE POINT.

**Separation Point.** The point on an aerofoil at which the boundary layer of the airstream separates from the aerofoil.

See also BURBLE POINT.

**Service Ceiling.** The height above sea-level at which an aeroplane is unable to climb faster than a defined rate, e.g. 100 ft. per min.

**Service Load.** The total weight of the crew and all the readily removable equipment which is not part of the main structure of the aeroplane.

**Service Tank.** The main fuel tank or tanks from which the engine is fed.

**Servo-amplifier.** The servo-amplifier is a polarity sensitive amplifier and rectifier which receives the signal from the selsyn control transformer and amplifies and rectifies it for the field of the amplidyne motor generator.

**Servo-control.** A servo-control is a device which assists the pilot's effort by mechanical or aerodynamic means and is similar in effect to a trimming tab.

**Sesquiplane.** A biplane which is constructed so that the area of one wing is half the area of the other or less, the lower wing being the smaller.

**Sextant.** An instrument by which the altitude of heavenly bodies is measured. It is also used to measure the angular elevation or depression of an object.

**Shallow Glide Bombing.** The term used to denote that the bombs are released by the normal level bombing technique with the aeroplane in a glide not exceeding 20°.

**Shamal.** A north-westerly wind occurring in summer over the Iraqi Plain.

**Shear.** The tendency of an external force to move or slide a part of a solid body past another part. A landslide is an example of shear.

**Shear Wires.** In an aerostat the crossed diagonal wires between adjacent transverse frames. They take the vertical shear.

**Sheathing.** A term used to denote a thin protective cover, e.g. thin sheet metal or other material attached to the tips and leading edges of wooden propeller blades to prevent damage by water, sand, etc.

This term is also used when referring to the covering of electric cables to prevent damage to the conductor.

**Sheer Plane.** Side elevation of hull or float, sometimes called sheer lines or sheer profile.

**Sheet Metal.** Metal which does not exceed  $\frac{1}{8}$  in. in thickness. When it is thicker than this it is known as plate.

**Shellac.** A resinous substance which is obtained from trees in the East Indies. Used as a waterproofing material and as an outer finish for wood.

**Shielding.** A term sometimes used when referring to the screening of the ignition system.

See also SCREENING.

**Shift of Butts.** An arrangement of shell plating on hull or float whereby the butts or laps of two adjacent strakes do not lie in the same vertical line, thus giving additional longitudinal stiffness.

**Ship Plane.** An aeroplane specially designed for the purpose of

rising from and alighting on the deck of a ship.

**Shock Absorber.** A part of the landing gear of an aeroplane which absorbs the shock when taking off, landing, or taxi-ing.

**Short Circuit.** The rendering of a part of a circuit inactive by the crossing of two conductors by a third conductor or by metallic contact of the positive and negative wires.

**Short Stacks.** A type of exhaust system for an internal combustion engine which consists of short lengths of tubing bolted to the exhaust port of each individual cylinder.

**Shower.** A precipitation of rain of short duration but often of considerable intensity. Showers fall from isolated clouds separated from one another by a definite clearance of the sky.

**Shrink.** The term used to denote the amount of contraction of cast metals when they cool and set from the molten state. Shrinkage allowance for cast iron is approximately  $\frac{1}{8}$  in. per foot, and this must be allowed for when making the pattern.

**Shrink Fits.** Fits in which a close binding of the parts is required. This is obtained by heating the external part before assembly.

**Shroud Line.** The term sometimes used when referring to the rigging lines of a parachute.

See also RIGGING LINES.

**Side-by-side Assembly.** An assembly of connecting-rods in which a number of rods are arranged side by side. The big ends are usually narrower, having roller bearings instead of plain bearings.

**Side-slip.** A manoeuvre of an aeroplane. The main object is to lose height without increasing the forward speed. This is obtained by side-slipping downwards.

See also **SIDE-SLIPPING**.

**Side-slipping.** A manoeuvre which is performed in normal flight for the purpose of losing height or counter-acting drift. In side-slipping the lateral axis of the aeroplane is inclined. The manoeuvre is carried out by use of the ailerons and opposite rudder in level flight.

**Side-slipping a Parachute.** When a group of rigging lines is pulled down on one side of a parachute it causes the parachute to move in the direction of the rigging lines which have been pulled. This enables the parachutist to control to a slight degree the direction of descent.

**Side-tracking Skate.** A device which assists the moving sideways of an aerodyne when on the ground.

**Signal Flare.** A pyrotechnic device of certain selected colours and characteristics for signalling purposes.

**Signal Rocket.** A rocket which is fired from the ground to help an aircraft to locate an aerodrome. It may also be used to convey instructions or information.

**Signalling Lamp.** A lamp which emits a defined light through a small aperture and which is used for visual signals.

**Silicon.** One of the non-metallic chemical elements, symbol Si. Silicon in some of its properties resembles carbon.

**Silver Solder.** Silver solder is a combination of silver, copper, and nickel, and is used for joining metals. The joint is stronger than that made by ordinary solder, but is weaker than a brazed joint.

**Simmonds' Nut.** Incorporates a special collar, keyed to prevent its rotation relative to the nut and having an internal diameter slightly less than the diameter of the bolt. Initially the collar is unthreaded.

When the bolt meets the resistance of the special collar it forces the nut upwards until the load-

carrying sides of the threads are under considerable pressure. The anti-rotational force thus exerted is very high, and prevents the Simmonds' nut from working loose under the most severe vibration.

After the upward pressure has reached its maximum the bolt makes its own thread through the collar, the elasticity of which provides an airtight grip and enables the nut to be used over and over again.

The Simmonds' nut is locked to the thread of the bolt, and is therefore independent of other locking devices.

**Simoom.** A hot, southerly wind of a dry nature which occurs in the deserts of Algeria, Syria, and Arabia. It is very similar to the Sirocco which occurs in the Mediterranean.

**Sirocco.** A warm, southerly wind in front of a depression which passes from west to east along the Mediterranean. It is usually characterized by a marked deterioration in visibility. This wind comes from the Sahara Desert, and reaches the North Coast of Africa as a hot, dry wind, but on reaching Southern Italy it is a warm moist wind due to the crossing of the Mediterranean where it collects moisture from the sea.

**Skew.** A term used to denote that two items or objects are not in true alignment.

**Ski.** Sled-like runners which are used on aeroplanes to replace the landing wheels for alighting on snow or ice.

**Skid.** A runner used as a member of the landing gear of a light aeroplane, and designed to assist the aeroplane in landing or taxi-ing, and to protect the fuselage from damage on landing. A tail wheel is substituted in many aeroplanes. The term is also used when referring to an aeroplane side-slipping outwards.

See also SKIDDING.

**Skidding.** The sliding outwards or upwards of an aeroplane on a turn because of insufficient bank for the amount of rudder or because of too much rudder in the direction of the turn.

**Skin.** The thin outer metal or wood covering of the fuselage or wings of an aeroplane.

**Skin Friction.** The resistance which is present on the surface of an aerofoil when passing through the air. The air is slowed up near the surface owing to the roughness of the surface and the viscosity of the air near the surface. This retards the airflow farther away from the surface.

**Sky Writing.** The emitting from an aircraft in the air of a trail of smoke. The direction of flight of the aircraft is so controlled by the pilot that it causes the trail of smoke to assume the form of letters or signs.

**Slat.** A movable automatic subsidiary aerofoil, attached to the leading edge of a main aerofoil which, when closed, falls within the contour of the main aerofoil. The slat moves forward automatically when the aerofoil is near the stalling angle and at this point the air passes through the slot, which is formed by the slat moving forward. The airstream over the main aerofoil is smoothed out and lift is still maintained.

See also SLOT.

**Sleet.** Precipitation in the form of melting snow or a combination of snow and rain.

**Sleeve Valves.** Admission and exhaust gases of an internal combustion engine may be controlled by specially shaped holes or "ports" in a single cylindrical sleeve which works between the cylinder and the piston. This sleeve, driven by special timing gear, partially rotates in the cylinder, at the same time

moving up and down. This motion causes the sleeve ports to uncover and close the cylinder ports at the correct time.

**Sleeves.** See DEFLATING SLEEVE; FILLING SLEEVE.

**Slip.** In relation to a propeller this is the difference between the geometrical pitch and the effective pitch.

**Slip Tank.** A fuel tank which, if necessary, can be jettisoned complete with its fuel.

**Slipstream.** The stream of air discharged aft by a revolving propeller.

**Slipway.** A special runway, usually of concrete, used for the handling of seaplanes into and out of the water.

**Slot.** An opening through a wing of an aircraft. Its object is to improve the airflow conditions over the main aerofoil at high angles of attack.

See also SLAT.

**Slotted Aerofoil.** An aerofoil having an air passage through a slot. The slot is so shaped that the portions of the aerofoil when separated are themselves of aerofoil section.

See also SLAT; SLOT.

**Slow Roll.** A manoeuvre of an aeroplane in which the ailerons are in the main responsible for the rolling motion about the longitudinal axis, the rudder and elevators being used to maintain the aeroplane in its direction of flight.

**Slug.** This is an engineering unit of mass. A slug expresses air density in terms of mass instead of force units. The similar unit in the metric system is known as kuks per cubic metre. A mass of one slug has a weight at the earth's surface of 32.2 lb.

**Small End.** The end of the connecting-rod which carries the gudgeon pin.

**Smoke Fog.** Fog which is due to



particles of smoke in the atmosphere. It is similar to a thick haze.

**Smoke Generator.** A pyrotechnic device which is dropped from an aircraft on to the land for indicating the wind direction or for determining the drift angle. It also refers to a device erected on an aerodrome which emits smoke to indicate the direction of the wind.

**Snap Gauge.** A gauge used for checking the accuracy of a shaft or circular bar. It is used where sections of the shaft are of such shapes that a ring gauge cannot be used. Snap gauges may be of the "go" or "not go" type.

**Snow.** Precipitation of water from the atmosphere in the form of feathery ice crystals.

**Soar.** A flight by a glider or by an aeroplane without motive power in which there is no loss of altitude.

**Soft Hail.** A precipitation of small white soft pellets which are opaque.

**Solar Day.** The time which passes between two successive crossings of the sun across the same meridian.

**Solar Time.** Time as indicated by the position of the sun in relation to the earth.

**Solenoid.** An electrical helical coil which consists of a large number of turns of fine wire in which an iron core is free to move. The electromagnetic force imparts linear motion to the iron core. This device is used to operate remote controlled switches.

**Solo.** A term used to denote that the pilot is the sole occupant of the aircraft.

**Sommerfeld Track.** This is a reinforced wire mesh runway. It is normally carried in rolls which are 10 ft. 7 in. wide and either  $12\frac{1}{2}$  yd. or 25 yd. long. It is used for constructing temporary runways and taxi tracks on temporary airfields.

**Sorbite.** A constituent of carbon

steel which is formed during the cooling process.

**S.O.S.** The international distress signal by wireless. In radio-telephony, the spoken expression "Mayday," which corresponds to the French pronunciation of the expression "m'aidez," is used.

**Sounding Balloon.** A free balloon which carries a set of self-registering instruments for meteorological purposes.

**Southerly Burster.** A colloquial name for line squalls in East and South-east Australia occurring most frequently during the rainy season. The wind changes from north-east to south-east or south,

**Southern Hemisphere.** That part of the earth lying south of the Equator.

**Span.** The total distance measured parallel to the lateral axis from wing tip to wing tip of an aeroplane.

**Spar.** The principal member of an aerofoil which supports auxiliary members such as the ribs.

**Spar Frame.** A strong transverse frame fitted in the hull of a flying boat. It takes the load from the main plane structure.

**Sparking Plug.** An electrical device which is incorporated in an internal combustion engine for igniting the fuel/air mixture. The body of the plug is insulated from the central electrode, the electric spark jumping the gap between the body and the electrode.

**Sparking Plug Reach.** The distance from the shoulder on the plug body to the tip of the electrodes.

**Specific Consumption.** The total amount of fuel, oil, oxygen, etc., which is used during flight. As regards fuel and oil this is normally stated in pints per brake horsepower per hour.

**Specific Gravity.** Specific gravity is generally determined by methods based on the law of Archimedes, i.e. that a solid, floating or immersed

in a liquid, loses weight equal to that of the liquid it displaces.

**Specific Heat.** The specific heat of a substance is defined as the number of calories necessary to raise the temperature of one gram of the substance 1° C. at any given temperature. The specific heat varies at different temperatures, therefore the temperature at which the increase by 1° C. is made should be specified.

**Speed.** The ratio of a unit of linear measure to a defined unit of time, i.e.

$$\frac{\text{Distance}}{\text{Time}}$$

See also AIR SPEED.

**Spill.** The escape of air at the periphery of the canopy of a parachute during descent. By spilling the air from the canopy a certain amount of control is obtained.

**Spin.** A manoeuvre which is the result of a stall. The aeroplane, which is still in a stalled attitude, loses altitude rapidly and travels downward in a spiral path.

**Spinner.** A fitting in the shape of a cone which revolves with the propeller to reduce the head resistance at the propeller boss.

**Spinning.** A process of shaping sheet metal into forms such as cones, basins, etc. It is first necessary to machine a wood or metal block to the dimensions required by the inside of the finished article. Spinings are made from aluminium, copper, and other ductile metals.

**Spiral Glide.** A continuous banked gliding turn with the angle of attack within normal range with the engine or engines giving no thrust.

**Spoiler.** See INTERCEPTOR.

**Spot Weld.** Spot welding generally refers to electrical resistance welding. It is a weld which is not a continuous seam, but is made only at defined intervals.

**Squadron.** A unit of the R.A.F. A flight formation consisting of two or three flights acting as one unit.

**Squadron Leader.** A rank in the Royal Air Force equivalent to Major in the Army, and Lieutenant-Commander in the Royal Navy. The badge of this rank consists of two rings of braid with a narrow ring of braid between fixed round the cuff of the sleeve.

**Squadron Officer.** A rank in the W.A.A.F. similar to that of Squadron Leader in the Royal Air Force, and designated by similar badges of rank.

**Squall.** A strong wind which rises and falls suddenly. Normally it lasts only for some minutes. It is frequently associated with a temporary change in wind direction.

**S.T.** Letters used to denote special transport aircraft. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Albemarle S.T. I.

**Stability.** The quality of a body or mass which, when disturbed from a condition of uniform motion, develops forces which tend to restore the body to its original condition.

In meteorology it is a state in which the vertical distribution of temperature is such that a particle of air will resist displacement from its position.

**Stabilizer.** An aerofoil which is fitted to an aeroplane to increase the stability, or in the case of a kite balloon a fabric fin filled with air or gas, and so designed as to increase the balloon's aerodynamic stability.

**Stable Air.** An air stratum in which the temperature decreases with increased height at a rate which is less than the dry adiabatic lapse rate if the air is unsaturated, and less than the adiabatic lapse

rate if it is saturated. The temperature may increase upward in very stable air.

**Stable Oscillation.** An oscillation which tends to damp out.

**Stagger.** When any one of a number of superimposed planes is ahead of the other, the planes are stated to be staggered. It is positive when the upper plane is in advance of the lower and negative when the lower plane is in advance of the upper.

**Stainless Steel.** The term stainless steel refers to a number of alloys which all contain chromium and nickel. Among their properties are high resistance to corrosion and strength at high temperatures.

**Stall.** The condition of an aerofoil or aeroplane which is operating above the angle of incidence corresponding to the maximum lift coefficient. It results in loss of flying speed and lift and finally loss of control.

**Stalling Speed.** The air speed of an aeroplane in steady flight at its maximum lift coefficient.

**Standard Air.** The density of air when the barometric pressure is 29.92 in. of mercury and the temperature 59° F. It is atmospheric air pressure of 14.7 lb. per sq. in. The standard air density is 0.07648 lb. per cub. ft.

**Standard Beam Approach.** This system enables a pilot to land on an airfield in extremely bad visibility. It consists of a main beacon transmitting a radio beam of a steady note, on one side of which is a dot signal, and on the other side a dash signal. To assist in the landing there are two other beacons, the inner marker beacon and the outer marker beacon.

**Standard Density.** See STANDARD AIR.

**Standard Horse-power of an Engine.** See RATED HORSE-POWER.

**Starboard.** The right-hand side of

an aircraft or ship as seen by an observer looking ahead.

**Starboard Drift Angle.** When the track of the aircraft is to the starboard of the aircraft.

See also PORT DRIFT ANGLE.

**Statchute.** A parachute which opens automatically when leaving the aircraft. It is operated by a cord, known as the static line, which is attached to the aircraft. This cord extracts the parachute from its casing, and when the stress exceeds 100 lb., the parachute breaks away from its casing and floats to earth in the normal way.

**Static Lift.** The difference between the weight of the air displaced by an aerostat on the ground and that of the gas in the aerostat.

**Static Line.** A cord which is connected to the pack of an automatic parachute and to the aircraft. The cord withdraws the parachute from the pack by the action of the load falling from the aircraft.

**Static Pressure Tube.** A tube used in instruments and specially designed to ensure that the pressure in it shall be static.

**Static Thrust.** The thrust developed by a propeller when rotating with the aeroplane stationary.

**Static Unbalance.** A propeller is stated to be in static unbalance if, when mounted concentrically on a spindle which is supported by knife edges, it will not remain at rest in all positions.

**Station (Frame).** Indicating point where frames are located. They are numbered from stem to stern of the hull or float.

**Statoscope.** An instrument which indicates very small changes in altitude.

**Statute Mile.** The British and American standard of linear measurement, 1760 yd. or 5280 ft. It is an arbitrary unit which has no connexion with any natural object.

**Steel.** An alloy of iron and

carbon. There are many types of special steels. The majority require other ingredients such as chromium, nickel, vanadium, or a combination of all three. Stainless steel, for instance, requires a high chromium content.

**Steel Wool.** Fine steel cuttings which may be used for the cleaning, finishing, or polishing of metal parts. Steel wool is obtainable in various grades—No. 0 (very fine), No. 1 (medium), and No. 3 (coarse). It should not be used on engine parts that cannot be cleaned afterwards to remove the steel fragments.

**Steep Glide Bombing.** The term used to denote that the bombs are released while the aeroplane is at an angle of dive up to 60°.

**Steep Turns.** A turn in which the angle of bank of the aeroplane varies from 45° to about 70°.

**Steerage Way.** When a float plane or flying boat has sufficient motion through the water to admit of controls being effective.

**Stem.** Foremost point of hull or float.

**Step.** A break in the under-water surface of a float or hull. It is designed to lessen the suction of the water, and to facilitate take-off.

**Stepped-down Formation.** The opposite of stepped-up formation (q.v.).

**Stepped-up Formation.** A flight formation in which the rear squadrons are at higher altitudes than those in front.

**Stern Plate.** Rearmost transverse frame of hull, where stringers terminate and to which they are attached.

**Stern Post.** The upright member at the after end of a fuselage or hull of an aerodyne.

**Stern Wave.** The eddies produced by the stern of a boat or seaplane hull moving through water. Energy is required for its formation, and

must be considered in estimating the resistance of the boat or hull.

**Stick.** A term often used when referring to the control column in most small aeroplanes. It is pivoted at its lower end.

**Stiffener.** Lengths of angle plate or similar members, attached to other members to give additional rigidity to a hull or float.

**Storage Batteries.** See ACCUMULATORS.

**Storm.** A term commonly used to denote a marked disturbance in the normal state of the atmosphere such as thunderstorms, rainstorms, snowstorms, hailstorms, etc. It is most often applied to a disturbance in which strong wind is prominent, and in particular to a wind of force "11" on the Beaufort scale.

**Strain.** The alteration or change which is produced in the dimensions of a body due to the application of an external force.

**Strake.** Any individual line of shell plating running horizontally fore and aft of a flying boat hull.

**Strato-cumulus.** A bank of cloud composed of large masses sometimes showing vertical structure. The masses are usually arranged in groups. When the sky is covered with this type of cloud layer it often has an appearance of rolls or waves. Considerable wind may be experienced just below the layer. Its average height is about 7000 ft.

**Stratosphere.** The outer layer of the atmosphere which is about one-quarter of the total atmosphere. It is free from clouds. The temperature in this layer is practically constant in an upward direction.

**Stratus.** Uniform layer of cloud similar to fog between the surface of the earth and an altitude of about 15,000 ft.

**Streamline.** A term used to denote the non-turbulent flow of a small amount of fluid passing over a solid body.

See also **STREAMLINE FORM**.

**Streamline Form.** The shape of a body about which there tends to be a streamline flow, i.e. there is only a very small amount of turbulent flow.

**Streamline Motion.** The motion of a fluid past a solid body when the flow is smooth and without turbulence.

**Streamline Wire.** A solid wire used in aircraft and of such a shape that it is approximately streamline in cross-section.

**Strength.** That property of a material which resists stress and deformation.

**Stress.** Internal action and reaction in a body which resists the tendency of an external force to change its size or shape, i.e. the resultant internal force resists any strain placed upon the body.

**Stress Analysis.** The examination of all the external loads and external reactions on a structure. This includes their respective magnitudes, directions, and points of application. Stress analysis is most important when dealing with air-frame structures.

**Striking Velocity.** The velocity of a bomb at the moment of striking the objective.

**Stringer.** An auxiliary member which is parallel to the main spars or longitudinals. This member assists in keeping the external form of aerofoils or other components in their correct shape. When applied to the hulls of flying boats it is normally called the keelson.

**Strip Map.** A special map compiled so that a course is clearly defined without having wide spaces on either side of it.

**Stroke.** The distance that a piston of an internal combustion engine travels in the cylinder from top dead centre to bottom dead centre.

**Structural Failure.** When, be-

cause of excessive stress, a member of a structure ceases to operate correctly it is said to fail structurally.

**Strut.** Part of the structure of an aircraft which resists compression in the direction of its longitudinal axis or its length.

**Stub Pipes.** Short pipes which convey exhaust gases direct from the combustion head of an internal combustion engine to the atmosphere in the absence of an exhaust manifold.

**Stub Plane.** A short plane which projects from and is usually part of a fuselage or hull. The main plane is connected direct to the stub plane.

A flying boat sometimes has a projection from the hull which is called a stub plane; it is fitted to give lateral stability on the water.

**"Stunts."** A colloquial term for aerobatics.

**Subsidence.** In aeronautics this is a disturbance which decreases without oscillation. In meteorology when more air flows out of a given area than flows into it, the difference must be made good by a downward current from the upper layers of the atmosphere. This downward current is known as subsidence.

See also **DIVERGENCE**.

**Sub-stratosphere.** The lower strata of the stratosphere.

**Sulphating.** The covering of the lead plates of an accumulator with a white deposit (lead sulphate). This occurs when the accumulator has been left uncharged for a lengthy period. Special treatment is required to prepare a sulphated accumulator for action again.

**Sumatra.** A squall which occurs in the Straits of Malacca and blows from the south-west. It is accompanied by thunder, lightning, and rain, and occurs most frequently during the night from May to October. It seldom exceeds a duration of two hours.

**Sump.** See DRY SUMP; WET SUMP.

**Super Heat.** The difference between the temperature of the gas in the envelope or gas bag of an aerostat and the temperature of the surrounding atmosphere. If the temperature of the gas in the aerostat is higher than that of the surrounding air it is called positive super heat.

**Supercharge.** To supply an internal combustion engine with more air or air/fuel mixture than would be induced at the existing atmospheric pressure.

**Supercharged Engine.** An engine in which the pressure in the induction system may be increased by mechanical means beyond that which would be produced by normal aspiration.

**Supercharger.** A mechanical device which increases the density of the fuel/air mixture entering the combustion chamber of an internal combustion engine.

**Surface Friction Drag.** That part of the total drag of an aerofoil which is due to the friction between the surface and the airflow.

**Surging.** A sudden rush of a fluid contained in a tank from one side of the tank to the other. This may be minimized by means of baffles fitted in the tank. In aircraft all tanks are fitted with baffles to avoid surging, as this affects the stability of the aircraft.

**Suspension Brackets.** Supports to which elastic cords are attached for the purpose of insulating delicate instruments against vibration.

**Sutton Harness.** This harness consists of four straps, two of which come up round the pilot's thighs and two over the shoulders. The four straps are fixed to a standard by a quick-release pin.

**Swage.** A machine for drawing metal into defined shapes.

**Sweepback.** A design in which the main planes slope backward from the longitudinal centre line of the aeroplane.

**Swell.** A wave motion which continues for some considerable time in the ocean after the cause of the disturbance has passed away. It is generally caused by a storm, and the resulting swells are usually regular wave motions which are long and low.

**Swing.** A term used to denote the pendulum-like motion of the falling load in a parachute. This motion is generally due to the initial tilting of the canopy.

**Swinging Base.** See COMPASS BASE.

**Switch.** An electrical device for altering the connexions of circuits.

**Switch Off.** A term used to indicate that the magneto of an engine is earthed and that the engine cannot be started until the magneto is switched on.

**Swivelling Propeller.** A propeller which can be turned so that the thrust can be transmitted in various directions.

**Synchronizing Gear.** A device or gear which stops and starts the firing of a gun by synchronizing the stopping with the position of the propeller. The gun ceases to fire at a position when the bullet might hit the propeller.

**Synoptic Meteorology.** This term denotes the compilation and presentation of meteorological conditions over a wide area of the earth's surface.

**Synoptic Weather Chart.** A chart which indicates the prevailing weather conditions over a wide area of the earth's surface.

## T

**T.** Letter used to denote trainer aircraft. The letter is used as a prefix for the mark number of the aeroplane and denotes its duty; for example, Hurricane T. I.

**Tab.** See TRIMMING TAB.

**Tachometer.** An instrument which shows the revolutions per minute of an engine crankshaft or other rotating part. Generally termed a revolution indicator.

**Tack Weld.** Welding method which is used temporarily to hold parts in place prior to the finished weld being commenced.

**Tail Boom.** A main spar connecting the tail unit and the main supporting surfaces of an aeroplane when there is no fuselage to perform this duty.

**Tail Float.** A watertight body giving buoyancy to a seaplane or amphibian which is attached to the tail unit.

**Tail Pipe.** An engine exhaust pipe fitted to lead the burnt gases away from the exhaust manifold to the atmosphere.

**Tail Plane.** A fixed aerodynamic horizontal surface which is part of the tail unit and affects the longitudinal stability of an aircraft.

**Tail Rope.** Rope which is trailed by a balloon over the ground to check the ground speed, and to regulate the height automatically when near the ground by the varying weight of the rope carried by the balloon.

**Tail Skid.** A member for supporting the weight of the tail of an aeroplane on the ground.

See also TAIL SKID SHOE.

**Tail Skid Shoe.** A replaceable metal covering on the end of a tail skid. This takes the wear when landing and taxi-ing.

**Tail Slide.** The position taken

up by certain aeroplanes after being brought into a stalling position. It is a downward motion with the tail preceding instead of the nose.

**Tail Unit.** The combination of the stabilizing and control surfaces at the rear end of an aerodyne. It includes the tail plane, fin, rudder, and elevator. Also known as "empennage."

**Tail Wheel.** A small wheel which is sometimes fitted in the place of a tail skid.

**Tail Wind.** A wind which increases the ground speed of the aeroplane. It is in the general direction of the flight of the aircraft.

**Tail-heavy.** The tendency for the tail of an aeroplane to sink when the longitudinal control is released in any given attitude of normal flight.

**Tailless Aeroplane.** An aeroplane so designed that stability and control are incorporated in the main planes. It is an aeroplane without a tail. The wings are swept back to a considerable extent, the control surfaces being at the tips of the wings, and the wing tips behind the centre of gravity.

**Take-off.** The procedure in which an aeroplane is accelerated from a state of rest to the time it is airborne.

**Take-off Run.** The distance which an aeroplane travels in contact with land or water during taking-off, starting from zero speed. Take-off distance is measured in a calm or at a specified wind velocity.

**Take-off Speed.** The air speed which is registered at the moment when an aircraft becomes entirely airborne.

**Tank Cooler.** A type of tank in which the cooler and oil tank are combined in one structure.

**Tank Vent Pipe.** An open-ended pipe leading from the air space in a gravity tank to the atmosphere. This is necessary in order to allow the fluid to flow freely by keeping the air in the air space at atmospheric pressure. This type of vent applies to both oil and fuel tanks.

**Tanks (Fuel).** See AUXILIARY TANK; GRAVITY TANK; MAIN TANK; SERVICE TANK; SLIP TANK.

**Tare Weight.** The weight of an aerodyne or aerostat in flying order complete with cooling liquid in the radiators, but exclusive of crew, removable equipment, and pay load.

**Tarmac.** See APRON.

**Taxi-ing.** The controlled movement of the aircraft on the ground or on the water when under its own motive power.

**Temper Brittleness.** Brittleness depends largely upon molecular arrangement. Steel when heated and cooled in water may be brittle, depending upon the tempering colour at which it is dipped in water. Brittleness can be removed by heating the metal again and cooling slowly, retempering if necessary.

**Temperature.** The thermal condition of an object.

**Temperature Gauge.** A gauge which indicates the temperature of a substance. Many different types are used in aeronautics for a large number of purposes.

**Temperature Gradient.** The rate of change of temperature. It may be related to altitude or distance.

**Temperature Inversion.** See INVERSION.

**Tempering.** Heat-treatment of hardened steel whereby it is made softer and less brittle. The metal in its fully hard state would be too brittle for certain operations and would break.

**Template.** A pattern which may be made of any suitable material. A template is also a means of checking the accuracy of a part.

**Tenacity.** The property of a material to resist fracture when under a tensile stress.

**Tensile Strength.** That characteristic of a body which tends to resist the forces which are attempting to lengthen or stretch it.

**Tensile Test.** A test which estimates the resistance of the material to stretching. In this test a suitably shaped test specimen of known dimensions is placed between the jaws of a testing machine. The specimen is marked so that when stretching commences under a gradually increasing load, measurements can be taken to determine the percentage of elongation. In addition, the following characteristics are obtained: elastic limit, modulus of elasticity, yield point, and ultimate strength.

**Terminal Nose Dive.** A dive at the highest value of the limiting velocity of the aeroplane.

**Terminal Velocity.** In aeronautics the highest value of the velocity that any aeroplane can attain in a dive.

**Terrestrial.** A term which is used when referring to the earth or anything appertaining to the earth.

**Terrestrial Meridian.** A great circle of the earth which passes through the North and South Poles.

**Tetra Ethyl Lead.** A volatile liquid,  $\text{Pb}(\text{C}_2\text{H}_5)_4$ , which when mixed with fuel lowers the rate of flame propagation, and thus assists in preventing detonation. Up to 4 c.c. per gallon of fuel is added, and the mixture is then coloured with dyes for identification. This colouring is necessary as the fumes are dangerous.

**T Head Cylinder.** A cylinder in which the valves are fitted to opposite sides of the combustion chamber of an internal combustion engine.

**Theoretical Best Gliding Angle.** The angle of glide, estimated mathematically, at which a particular



aeroplane can be expected to glide in still air to reach the farthest point on the earth's surface.

**Theory of Dimensions.** A term used when referring to the testing of scale models in a wind tunnel.

See also REYNOLDS' NUMBER.

**Thermal Conductivity.** The ability of a metal or other substance to transmit heat to another metal or substance or another part of itself.

**Thermal Convection.** The movement of a fluid which is caused by temperature variations.

**Thermal Efficiency.** The ratio of the heat transformed into mechanical work to the heat received from the burning of the fuel.

**Thermal Soaring.** Glider soaring by using the up currents caused by air being heated by contact with the earth.

**Thermite Bomb.** A type of incendiary bomb which is basically ground iron oxide and magnesium. It produces intense heat on ignition.

**Thermo-couple.** When certain different metals are in contact with one another an electromotive force is produced if the temperature is varied. This electromotive force can be measured by a sensitive galvanometer, and is transferred into the degree of change of temperature of the metals.

**Thermodynamic Duct.** This is a propulsion unit of the impulse duct type. In the front there is a gill containing a number of jets, and an arrangement of shutters which close when the pressure within the duct is greater than that in front of the gill, and open when the reverse conditions obtain. The initial ignition is provided by a sparking plug. The engine operates intermittently in conformity with the closing and opening of the shutters. The fuel used in this type of impulse duct engine is a low-grade fuel.

**Thermodynamics.** The science which deals with the relationship

between heat and mechanical energy.

(a) Heat and mechanical energy are mutually convertible.

(b) Heat cannot pass from a cold body to a hot one without the expenditure of work.

**Thermo-electricity.** When two different metals are joined together and one end is heated whilst the other remains cold, an e.m.f. is generated across the junctures and a current flows through the metals. This effect is used in some forms of measuring instruments.

See also THERMO-COUPLE.

**Thermogram.** The record of the variation of temperature which is made by a thermograph.

**Thermograph.** A self-recording thermometer.

**Thermometer.** An instrument for measuring temperature.

See also MAXIMUM THERMOMETER; MINIMUM THERMOMETER; WET AND DRY BULB THERMOMETER.

**Thermo-plastics.** This term refers to plastics which are subject to chemical change at certain temperatures, and are therefore unsuitable for use in conditions where these temperatures might be met. They can be heated and reshaped. Celluloid is a thermo-plastic.

**Thermo-setting Plastic.** This term refers to plastics which once formed are not chemically affected, and cannot therefore be reformed by heat and pressure. Bakelite is a thermo-setting plastic.

**Thimble.** In engineering this is a short hollow cylinder fitted snugly over a shaft or rod, generally for reinforcement or protection. It differs from a sleeve in that there is no relative rotational movement between it and the shaft.

In nautical terms it refers to a heart-shaped metal grooved reinforcing ring, around which a cable is passed before splicing, the

purpose of which is to prevent wear and sharp bending of the cable.

**Thread Gauge.** A gauge which is used to determine the type of threads, or the correct shape of threads.

**Three Point Landing.** A normal landing in which the two main wheels and the tail wheel or skid touch the ground simultaneously.

**Throttle.** The pilot's control which operates the butterfly valve in the carburettor. This valve controls the amount of fuel/air mixture which enters the intake manifold and so governs the engine speed and the power output of the engine.

**Throttle Gate.** A method used to guard against excessive opening of the throttle below a predetermined altitude.

**Thrust.** A component of the resultant air force on a propeller. This thrust is parallel to the propeller axis. When the aeroplane is stationary it is known as static thrust.

**Thrust Bearing.** A bearing which has been designed to take a load in a direction parallel to the shaft which is rotating in the bearing.

**Thrust Wire.** A wire which is led aft and transmits the thrust from the power unit to the envelope of an aerostat.

**Thunder.** The sound which is the result of a discharge of electricity in the atmosphere.

**Thunderstorm.** A storm which is accompanied by thunder and lightning. It is a local disturbance, marked by rapid variations in pressure, temperature, and the direction of the wind.

**Tie Rods.** Steel rods of various cross-section used for internal and external bracing of parts of structures.

**Time Lag.** The difference between the time taken for a bomb to strike

the objective under normal conditions and the time of fall from the same height if it were in a vacuum.

**Timing Disc.** A disc which is designed to measure the crankshaft rotation and determine its position in relation to the position of the piston in the cylinder of an internal combustion engine. It is used for timing the ignition or valves of an engine.

**Tin.** One of the chemical elements, symbol Sn. It is used as an alloy with other metals. It is also one of the metals used for solders.

**Tip Vortex.** See WING TIP VORTICES.

**Titanine.** The trade name for certain aircraft dopes and other compounds used as finishers for aircraft fabricated parts.

**Tolerance.** The upper and lower engineering limits from a stated dimension which are specified on engineering drawings. These limits are necessary in order to obtain the required standardization from a strength aspect as well as from the point of view of interchangeability of parts.

See also LIMITS.

**Tool Steels.** These are steels with a carbon content varying from 0.70 to 1.50 per cent, with varying percentages of manganese, tungsten, chromium, molybdenum, or vanadium. Such steel is used for the manufacture of cutting tools, because after heat-treatment the metal has a considerable hardness and often has a high thermal stability.

**Top Dead Centre (T.D.C.).** The position when the piston is at the greatest distance from the centre line of the crankshaft, i.e. it is at the top of the stroke.

**Top Overhaul.** The stripping of an aircraft engine as far as the crankcase and overhauling of the engine without further dismantling, i.e. the grinding in of the valves,

examination and decarbonization of the piston and cylinders, examination and replacement of the small ends, piston rings, etc.

**Topography.** The descriptive feature of a part of the earth's surface.

**Topping Up.** The filling up of a partially filled aerostat with more gas to meet its operation pressure. Also applied to a similar operation with accumulators when filling up to the required level with distilled water.

**Tornado.** A storm with a violent whirl of small radius advancing over the land in which winds of destructive force circle round the centre and form a region of strong ascending currents. Such storms have been known to destroy whole towns, tearing down trees and buildings, etc.

In West Africa a squall which accompanies a thunderstorm is called a tornado. It occurs between the rainy and dry seasons.

**Torpedo.** A vessel of steel containing a charge of high explosive and used as a weapon by aircraft and seacraft. It is in three sections: (a) the head carrying the charge and firing mechanism; (b) the compressed air chamber; and (c) the power unit which propels the torpedo through the water. The compressed air chamber is heated by fuel to obtain greater power for driving the engine. A torpedo is discharged from aircraft by means of a specially devised launching gear.

**Torpedo Carrier.** A term generally used to define an aeroplane designed for carrying torpedoes, but more correctly it is the device fitted to an aeroplane for carrying the torpedo.

**Torpedo Release Control.** A control fitted to a torpedo carrier which operates one or more torpedo release slips.

**Torpedo Release Slip.** A device

which releases or allows the torpedoes to slip from a torpedo carrier.

**Torpedo Sight.** An instrument which is designed to assist the aimer or pilot in laying a course for the correct aiming of a torpedo at its objective.

**Torque.** A force applied in such a way as to tend to cause rotation. In aeronautical engineering it is the moment about the propeller axis of the air forces on the propeller, and tends to make the aeroplane revolve round the propeller shaft.

**Torsion Test.** A test which indicates the amount of torque necessary to rupture a metal. The metal test specimen is placed in a stationary vice, and the free end in a jaw free to turn about an axis which is parallel to the centre line of the specimen. The jaw is rotated. This twists the specimen and the breaking point is noted.

**Toughness.** The ability of a material to withstand a direct load without failure.

**Townend Ring.** A ring fitted in the streamline cowl and round a radial engine to reduce the drag of the engine by deflecting inwards the air flowing past it. It is of aerofoil section.

**Track.** The true path of the centre of gravity of an aircraft over the earth's surface.

**Track Angle.** The angle between the track of an aircraft and a true meridian. It is measured in a clockwise direction up to a full circle of 360°.

**Track Distance.** The distance in a direct line on the earth's surface under the position of an aircraft in the air to the point from which it started its flight.

**Tractor Aeroplane.** An aeroplane whose propeller or propellers are in front of the main planes.

**Tractor Engine.** An engine to which a tractor propeller is fitted.

See also **TRACTOR PROPELLER**.

**Tractor Propeller.** A propeller which is fitted in front of the main supporting planes, i.e. in front of the engine, and tends to pull the engine forward. Most British aircraft have their propellers fitted in this way.

**Trade Winds.** Persistent winds blowing towards the Equator from the north-east in the northern hemisphere, and from the south-east in the southern hemisphere.

**Trail Angle.** The angle a bomb is observed to fall behind the vertical when the aircraft is in level flight at constant speed as seen from the aircraft.

**Trail Distance.** The distance which a bomb falls behind the vertical from an aircraft at constant speed in level flight.

**Trailing Aerial.** An aerial for radio communication which has a small weight secured to its free end. It is trailed from an aircraft in flight.

**Trailing Edge.** The aftermost edge of an aerofoil or propeller blade.

**Trailing Edge Vortices.** The vortices which flow in different directions just behind the trailing edge of a wing.

**Trajectory.** In ballistics this refers to the curved path of a bullet or bomb. In meteorology it refers to the path followed by a small mass of air in its movement over the surface of the earth.

**Trajectory Band.** A band made of webbing which is carried over the upper surface of an envelope of an aerostat and reduces the deformation of the envelope when under load.

**Tramontana.** A wind from the north which blows down the mountains in Italy.

**Transporter Tower.** A mast which is mounted on a movable platform for handling airships when on the ground and for mooring them.

**Transverse Load.** A load applied across the length of a structural member.

**Transverse Frames.** See **MAIN TRANSVERSE FRAME**; **INTERMEDIATE TRANSVERSE FRAME**.

**Tricycle Landing Gear.** A three-wheeled landing gear of an aeroplane in which the front wheel is placed well forward of the fuselage, the two rear wheels being located a short distance behind the centre of gravity.

**Trim.** In aerostats, this denotes the condition of balance. To trim an aeroplane means to adjust the controls and the supporting surfaces so that the aeroplane is in balance and capable of maintaining a normal attitude of flight without undue use of the controls.

The trim of a float or hull of a seaplane is the angle of the load line of the hull or float with the surface of the water.

**Trimming Tab.** A small auxiliary hinged portion controlled independently of the main controls. It is inset into the trailing edge of an aileron, rudder or elevator. A trimming tab holds the control surface to which it is fixed in the correct position for normal level flight.

**Triplane.** An aeroplane with three superimposed wings, one above the other. They may be staggered.

**Troop Carrier.** A term used to denote an aeroplane which has been designed specially for the transport of troops.

**Troostite.** A constituent of carbon steel. It is formed during the cooling process.

**Tropical Cyclone.** See **TROPICAL REVOLVING STORM**.

**Tropical Maritime Air.** Used to describe any air mass that originates over the sea in the tropics. It has high temperature and humidity.

**Tropical Revolving Storm.** A

depression which originates over tropical oceans and is accompanied by strong winds. It is very often of hurricane force, and revolves counter-clockwise in the northern and clockwise in the southern hemisphere.

**Tropical revolving storms** are known as hurricanes in the West Indies, typhoons in the China Seas, Willy-Willy in Australia, and cyclones in the Indian Ocean.

**Tropopause.** The vertical height from the surface of the earth at which the normal fall of temperature with increasing height ceases suddenly. It is the boundary between the troposphere and the stratosphere. Its average height is about 8 miles, being about 6 miles at the polar regions, and over 9 miles at the Equator.

**Troposphere.** The inner layer of the atmosphere extending from the earth's surface to a height of over 9 miles at the Equator, and about 6 miles at the poles.

**Trough.** A "valley" of low barometric pressure, the opposite of ridge.

**True Air Speed.** The speed of the aeroplane in relation to the air through which it is moving.

**True Course.** The course as indicated by the angle between the geographical north and the longitudinal axis of the aircraft. It is measured in a clockwise direction from the true meridian.

**True Meridian.** See GEOGRAPHICAL MERIDIAN.

**True North.** This is the direction of the geographical North Pole from the observer.

**True Track Angle.** The track angle in relation to the true meridian.

**Truss.** A rigid structure designed to carry lateral loads. It may be H or T in shape, and consist of rods, tubes, wires, etc. It may be of composite construction of many

materials. A truss consists of top and lower main members and vertical or diagonal struts.

**T Sections.** Sections whose cross-section is shaped like a letter T.

**T.T.** Letters used to denote target tug aircraft. The letters are used as a prefix for the mark number of the aeroplane and denote its duty; for example, Lysander T.T. III.

**Tumblehome.** A term used in hull construction. It is the inward slope from the chine to the gunwale.

**Tuner Box.** An instrument used for direction finding in radio communication.

**Tungsten.** One of the chemical elements, symbol W. It is a heavy white metal with a specific gravity of 19.6. Tungsten has the highest tensile strength of any metal, with a Brinell hardness of 290 and a melting point of 3400° C. It is used in high-speed and special alloy steels.

**Turbulence.** Irregular motion of a fluid when it flows over an uneven surface or a surface at too great an angle of attack to the airflow.

**Turbulent Flow.** The irregular movement of a fluid over a surface or body.

**Turn.** The change in the direction of flight of an aircraft.

**Turn and Bank Indicator.** An instrument combining a turn indicator and a cross level.

**Turn Indicator.** An instrument which indicates any deviation or turning movement about the vertical axis of the aeroplane.

**Turnbuckle.** This consists of two eye bolts with a left-hand thread on one and a right-hand thread on the other which screw into the opposite ends of a barrel. It is employed to adjust the length of wires by turning the barrel.

**Turpentine.** A colourless liquid produced from the resinous substance obtained from pine trees. Used as a solvent for enamels, varnishes, and paints.

**Turret.** The movable structure of an aeroplane which is designed for the use of an air gunner.

**Twilight.** Twilight is the short period between sunrise or sunset and the total darkness of night.

**Twilight Zone.** A narrow strip of overlapping signals in the standard beam approach system used for the landing of aircraft in bad visibility. In this zone the dot and dash signals can scarcely be distinguished above the background of the steady beam note.

**Two Phase Supercharger.** See TWO SPEED SUPERCHARGER.

**Two Point Landing.** A landing in which the two main wheels of the normal landing gear touch the ground first. The tail skid or wheel

touches the ground after the forward speed has decreased.

**Two Speed Supercharger.** This unit incorporates two gear ratios, which enable the blower to be driven at either medium or high speed according to the requirements at sea level or high altitude.

See also SUPERCHARGER.

**Two Stroke Engine.** An engine which has one power stroke for each revolution of the crankshaft as opposed to the four stroke engine. The intake and compression of the fuel/air mixture takes place during one stroke and the power and exhaust at the other stroke of the piston.

**Typhoon.** See TROPICAL REVOLVING STORM.

## U

**Ultimate Load.** A defined load below which a structural member or part should not fail.

**Ultimate Strength.** The ultimate strength of a material is the maximum stress per unit area that it will withstand under an applied load.

**Uncontrolled Spin.** A spin which commences without the use of the controls, and from which the controls are of little or no use in effecting a recovery.

**Under Way.** A term used to denote that an aircraft or ship is moving. It is not necessary for the aircraft or ship to be moving under its own power. If it has momentum it is under way.

**Undercarriage.** The items of the landing gear of an aeroplane which include the main wheels, skids, or floats.

See also ALIGHTING GEAR.

**Undershoot.** Failure to extend the glide of an aeroplane to the landing area.

**Underslung Radiator.** A liquid-cooled radiator which is suspended below the fuselage of the aircraft.

**Uniform Acceleration.** Acceleration in which the velocity increases or decreases at a uniform rate. In the latter case it is generally called uniform deceleration.

**Uniform Velocity.** A velocity which is constant, i.e. with no positive or negative acceleration.

**Units of Linear Speed.** The most common units of linear speed are: miles per hour (m.p.h.); knots

(nautical miles per hour); kilometres per hour.

**Unstable Air.** In meteorology this term is used for an air layer in the atmosphere in which the temperature decreases with height at a more rapid rate than the adiabatic lapse rate. This condition sets up vertical air currents.

**Unstable Oscillation.** An oscillation whose amplitude tends to increase continuously.

**Unstick.** A term which indicates the instant when an aerodyne definitely leaves the land or water during the take-off.

**Upward Spin.** A flying manoeuvre. The aeroplane is pulled up into a vertical climbing position, and is then rolled about its longitudinal axis.

**Urea.** The name given to a material used in the manufacture of plastics, produced by heating carbon dioxide and ammonia under high pressure.

It is in the thermo-setting class, which means that it will flow at a certain temperature to allow it to be moulded to shape, but, once cooled will not again attain the plastic condition on reheating. When used for the manufacture of articles it is associated with formaldehyde, together with a suitable "filling" such as china clay, french chalk, etc.

**Useful Lift.** The lift available for carrying passengers, supplies, cargo, etc.

**Useful Load.** See PAY LOAD.

## V

**Vacuum.** A space free of all matter.

**Vacuum Flight Path.** The path of a bomb if it were dropped in a vacuum.

**Valley Breeze.** An anabatic wind which, when the sun warms the earth, blows up valleys and mountain slopes. It does not occur during the night.

**Valve.** A device for controlling the passage of fluids and gases through tubes, pipes, etc. In an internal combustion engine it controls the supply of the fuel/air mixture to the combustion chamber and the passage of the burnt gases to the atmosphere.

**Valve Hood.** A hood fitted to protect any valve on an envelope of an airship against the weather.

**Vanadium.** One of the chemical elements, symbol V. Specific gravity 5.68. Melting point 1720° C. It is a silvery brittle metal, and is used in special alloy steels. Vanadium increases the toughness of steel and increases its fatigue resistant qualities.

**Vane.** A device which indicates the direction of the wind; generally termed a weather or wind vane.

**Vane-type Supercharger.** A rotary blower in which compression is effected by the motion of rotating vanes in a casing.

**Vaporizer.** A vessel employed for storing and evaporating liquid oxygen in connexion with high altitude equipment.

**Vapour Capacity.** The capacity of air to hold water vapour.

See also RELATIVE HUMIDITY.

**Vapour Lock.** A term sometimes used to denote a condition arising in the fuel lines, due to formation of vapour, which interferes with the liquid flow of the fuel.

See also AIR LOCK.

**Vapour Trails.** The white trails visible behind aircraft in flight under certain conditions are due to two causes, viz., the engine exhaust and wing tip vortices. Aero engine fuel contains a considerable amount of hydrogen which after combustion passes out of the exhaust in the form of water vapour. This steam under normal temperature conditions is invisible, but when the surrounding air is already saturated with water vapour, as it may well be at the low temperatures encountered at altitude, it cannot contain any more water, consequently condensation takes place, and the result is enduring trails of visible cloud.

The wing tip trails are produced as follows. Under flight conditions the pressure of the air on the under side of the wing is greater towards the middle of the span than it is at the wing tip, whilst on the upper surface the converse is the case. As air always tends to move from a point of high pressure towards a point of lower pressure, it will be clear that the pressure conditions above and below a wing, already mentioned, will combine to cause a vortex to form at the wing tip. The centrifugal force due to a rapidly rotating vortex reduces the air pressure at its centre with corresponding expansion and drop in temperature. If this is occurring in air of high humidity condensation will occur, thus forming visible trails at the wing tips. At low altitudes where the temperatures are higher, wing tip trails generally disappear with the decay of the vortex by the re-evaporation of the water particles.

**Variable Area.** Usually refers to any mechanical means which varies



the effective wing area, i.e. increases the area to obtain greater lifting capacity for taking off and landing.

**Variable Camber.** Variable camber refers to the methods of varying mechanically the camber of an aerofoil during flight. Wing flaps have proved the most successful of all experiments, but these are not in a mechanical sense variable camber aerofoils.

**Variable Incidence.** This refers to mechanical means of altering the angle of incidence. Variable incidence has so far proved to be of no value.

**Variable Pitch Propeller.** A propeller whose blades are mounted so that they may be turned about their axes to a required pitch whilst the propeller is rotating. This term should not be used when referring to a propeller whose blades are adjustable only when it is stationary.

**Variation.** A term used to denote the horizontal angle between the magnetic north and the true or geographic north at any specified place.

See also MAGNETIC VARIATION.

**Varnish.** A solution of resins which forms a transparent, hard, shiny surface on drying. It gives a smooth surface on materials and protects them against the weather. Used on wooden parts of aircraft.

**Vector.** A vector is a line representing a quantity which has (a) magnitude; (b) direction; (c) point of application. The length of the line drawn to any convenient scale gives its magnitude. The angle and position of the line shows its direction.

**Vector Computer.** Known colloquially as a course and distance calculator or a course and speed computer. It is a device which enables vector triangles to be represented. The following can be determined: air speed, course, ground speed, track, wind direction, and wind speed.

**Vector Diagram.** A diagram representing directions and magnitudes by means of lines.

See also VECTOR COMPUTER.

**Vector Triangle.** A diagram in the form of a triangle in which one side indicates the resultant of two forces, velocities, etc., acting on an object.

See also VECTOR DIAGRAM; VECTOR COMPUTER.

**Vee Formation.** An ordinary flying formation which consists of three or more aeroplanes arranged in the shape of a letter "V."

**Veer.** The movement of the wind in a clockwise direction. In meteorology this definition applies to both hemispheres.

**Veering.** An alteration of wind in a clockwise direction, the opposite to backing.

**Vegetable Lubricants.** Lubricants which are made from vegetable matter. They have a tendency to oxidize when exposed to the atmosphere. Vegetable lubricants are not in general use for aircraft engines.

**Velocity.** The rate at which a particle changes its position, generally referred to as miles per hour, or feet per second. Acceleration is the rate of change of velocity with respect to time.

**Velocity of Sound.** In air this is 1090 ft. per sec. at ground level.

**Vendavales.** A wind from the south-west in the Straits of Gibraltar.

**Veneer.** Thin sheets of wood glued over inferior wood to give an ornamental appearance.

**V Engine.** An engine having its cylinders forming the letter "V" as seen from the front or rear end.

**Vent.** A term used to denote the orifice in the canopy of a parachute to permit escape of air during descent.

**Venturi.** A tube having a smaller diameter in between a large opening in the front and one in the rear.

The fluid flow through the smaller neck causes a pressure drop in the narrowest section, the drop of pressure being a function of the velocity of the flow of the fluid. It is used in a carburettor to increase the flow of air, and thus increase the suction over the fuel jet.

**Verge Ring.** The verge ring is fixed round the edge of the bowl of a compass. On this ring the grid ring rotates.

**Vernier.** An auxiliary scale which measures fractions of a main scale when the reading of the whole division on the main scale is not sufficiently small. It is used on precision instruments.

**Vertical Air Photograph.** A photograph made from the air with the camera fixed so that it points vertically downward.

**Vertical Axis.** See NORMAL AXIS.

**Vertical Bank.** Angular displacement of an aeroplane about the longitudinal axis from approximately  $70^\circ$  to  $90^\circ$  for the purpose of turning.

**Vertical Engine.** An internal combustion engine which has its cylinders arranged vertically above or below the crankshaft. When they are below the crankshaft it is generally referred to as an inverted engine.

**Vertical Structure Clouds.** These clouds form in an upward direction and have a height up to 25,000 ft. Cumulus and cumulo-nimbus are of this type.

**Vertical Temperature Gradient.** The rate of change of temperature with height. For meteorological purposes it is considered as  $1^\circ\text{F}$ . per 300 ft.

**Vibration.** Regular oscillation or reciprocating motion set up in ether or matter by various forces, or a movement characterized by a number of complete reversals of direction. When the movement is slow, as in the movement of a pendulum,

the term oscillation is more commonly used. Vibrations may be regular or irregular in relation to amplitude and frequency.

**Viscosimeter.** A device for measuring the viscosity of fluids; this instrument records the time necessary for a known quantity of fluid at a given temperature to flow through a defined orifice.

**Viscosity.** The internal friction or resistance of a fluid. It is that property which when a solid body is passed through a fluid sets up forces in a direction so as to oppose the motion of the solid body. It can be considered as the degree of "stickiness" of the fluid. Different liquids have different degrees or coefficients of viscosity, and these vary at different temperatures. This property has the effect of destroying wave motion.

**Visibility.** Quality or state of being visible. The greatest distance at which objects can be seen and distinguished.

See also APPENDIX B.

**Visibility Meter.** An instrument which, by adding artificially to the obscurity of the atmosphere, determines visibility.

**Volatility.** The property of a liquid which indicates that it can change easily into a vapour. The volatility of a fuel is important from an aeronautical aspect. Fuel should be sufficiently volatile to ignite at low temperatures.

**Volt.** The unit of electromotive force, pressure or potential difference. One volt is the pressure which when applied to an electrical conductor whose resistance is one ohm will produce a current of one ampere.

**Volume.** A measure of cubical dimensions.

**Volumetric Efficiency.** The ratio between the volume of fuel/air mixture drawn into the cylinder of an internal combustion engine and that





and squally winds. The isobars are normally in the form of an inverted "V."

**Weft.** See WARP.

**Weight.** The force which is exerted upon a body because of the earth's attraction. Weight is mass  $\times$  the force of gravity, which is only constant at the same level and latitude.

**Weight of Air.** In standard air conditions the weight of air is 0.0765 lb. per cub. ft.

**Weight per Brake Horse-power.** The dry weight of an engine divided by the rated brake horse-power.

**Weights.** See DISCHARGEABLE WEIGHT; FLYING WEIGHT; GROSS WEIGHT; GROSS DRY WEIGHT; NET DRY WEIGHT; TARE WEIGHT; WEIGHT; WEIGHT OF AIR; WEIGHT PER BRAKE HORSE-POWER.

**Weld Continuity.** The term used to denote the degree of continuity in a weld. It is classed as continuous, intermittent, or tack.

**Welding.** The method of obtaining an intimate union of similar metals by the use of an extremely hot flame produced by igniting oxygen-acetylene or oxygen-hydrogen at the tip of the welding blowpipe, or by electrical resistance methods. The metals are fused together by the heat. A welding rod of similar metal is often necessary.

**Welding Jig.** A rigid structure which holds the component parts of a structure in their correct position while the work is being welded.

**W Engine.** See ARROW ENGINE.

**Wet and Dry Bulb Thermometer.**

An instrument used to indicate the relative humidity of the atmosphere. It consists of two thermometers hung side by side in a special metal case having an open front. The bulb of one thermometer is covered by a muslin bag joined to a cotton wick which dips into a small glass

vessel containing water. The water soaks up the wick and muslin, thus keeping the bulb wet. When the atmospheric air is dry the water will evaporate rapidly from the muslin, thus cooling the bulb. The consequence is that the reading of the wet bulb thermometer may be several degrees lower than that of the dry bulb thermometer at its side. Conversely, when the air is damp, the rate of evaporation is less and therefore the cooling effect on the wet bulb is less. Hence by comparing the readings of the two thermometers a measure of the humidity of the air may be obtained; if both thermometers read the same the air is saturated, and if there is a wide divergence the air is dry.

See also PSYCHROMETER.

**Wet Bulb.** See WET AND DRY BULB THERMOMETER.

**Wet Bulb Thermometer.** Similar to a dry bulb thermometer except that the bulb at the base of the thermometer is covered with muslin and kept moistened.

See also WET AND DRY BULB THERMOMETER.

**Wet Fog.** Fog which has a very high relative humidity. Objects exposed to this type of fog become very wet.

**Wet Sump.** An oil sump in the lower half of the crankcase of an internal combustion engine. In this type of internal combustion engine the sump carries all the oil for the engine. The oil, after circulating through the bearings, etc., is returned to the sump via a filter for further use.

**Wetted Surface.** The amount of surface of a body moving in a fluid which is in contact with the fluid at any specific time.

**Wheeling Machine.** A machine which stretches and shapes sheet metal as it is being hand fed under the roller. Used for the shaping or

reshaping after damage of aircraft panels, etc.

**Whirling Arm.** A device designed for aerodynamic experiments. Instruments or models are attached to the end of a rotating arm.

**Whirlwind.** A region in which air revolves rapidly round a core of low pressure. It is limited in its width, but may be many hundred feet high.

**Willy-Willy.** See TROPICAL REVOLVING STORM.

**Wind.** Air in motion, usually with a common direction of motion. The term is generally used when referring to air moving horizontally, vertical movements of the air being referred to as currents or vertical currents.

**Wind Cone.** A tapered fabric sleeve for indicating the direction and strength of the surface wind. It is erected on a mast at airfields for the information of the pilot.

**Wind Direction.** The direction from which the wind is blowing.

**Wind Gauge Sight.** An instrument by which the track of an aircraft can be determined by altering direction to two or more courses. From the information obtained the wind, air, and ground speed can be represented by vectors.

**Wind Indicator.** An instrument which indicates the direction and the velocity of the wind.

**Wind Shift.** A sudden veer of the wind. It is usually accompanied by squalls and is associated with the passage of a cold or occluded front.

**Wind Sock.** See WIND CONE.

**Wind T.** A large T-shaped weather vane to indicate the direction of the wind. It may be set by hand or be adjusted automatically.

**Wind Tunnel.** An apparatus for producing a uniform steady artificial wind in which objects are placed for investigating the airflow over their surfaces and for aerodynamic experiments.

See also CLOSED JET WIND

TUNNEL; COMPRESSED AIR WIND TUNNEL; NON-RETURN FLOW WIND TUNNEL; OPEN JET WIND TUNNEL; RETURN FLOW WIND TUNNEL.

**Wind Velocity.** The rate at which a wind is blowing. Usually expressed in miles per hour, or in accordance with the Beaufort scale.

**Windmill Pump.** A type of fuel supply pump which is driven by a propeller. The propeller by virtue of its motion relative to the air rotates and so develops power.

**Windward.** The direction from which the wind blows in relation to a definite point.

**Wing.** A general term applied to an aerofoil which has been designed to develop lift for a heavier-than-air aircraft.

The term also refers to a Royal Air Force formation which consists of two or more squadrons.

**Wing Area.** Wing area always refers to the total area of the supporting surfaces of the aeroplane, including the ailerons. For calculating this area a wing is considered to pass through the fuselage without interruption.

**Wing Car.** A car of an airship which is suspended to the port or starboard of the centre line.

**Wing Commander.** A rank in the Royal Air Force equivalent to a Lieutenant-Colonel in the Army and a Commander in the Royal Navy. The badges of this rank consist of three rings of braid round the cuff of the sleeve.

**Wing Drag.** The induced drag plus profile drag acting on a wing.

**Wing Flaps.** Wing flaps are hinged sections of the trailing edges of a wing. Wing flaps are used to decrease the landing speed of an aeroplane, and some flaps are so designed that they assist in quicker take-off and improved climb.

**Wing Loading.** The maximum flying weight of an aeroplane divided

by the area of the main planes. The main planes include the area of the ailerons.

**Wing Officer.** A rank in the W.A.A.F. similar to that of Wing Commander in the Royal Air Force, and designated by similar badges of rank.

**Wing Radiator.** A cooler for a liquid-cooled engine in which the wing surface is utilized for cooling purposes.

**Wing Rib.** See RIB.

**Wing Root.** The end of a wing where it joins the fuselage or centre section.

**Wing Skid.** A wooden half hoop sometimes placed under the wing tip to protect it from contact with the ground during take-off and landing.

**Wing Slots.** See SLOT.

**Wing Tip.** The extreme end of the supporting surfaces of an aeroplane.

**Wing Tip Flare.** A device attached to the wing tips of an aircraft which when fired by the pilot illuminates the ground while landing.

**Wing Tip Float.** A watertight structure giving buoyancy to a sea-plane or flying boat and mounted at the wing tips to prevent the wings touching the water.

**Wing Tip Vortices.** The whirling or circulatory airflow at the wing tips. It is caused by the air flowing out from the high pressure area on the under surface of the wing, and fusing into the low pressure area on the upper surface of the wing.

**Wing-heavy.** The condition of an aeroplane when the right or left wing tends to fall when the lateral control is released in normal flight.

**Wire Locking Ring.** A device in the form of a ring used for locking two or more items together, and made of strong, spring steel wire. One end is bent at right angles to its own plane for insertion into a hole drilled for locking purposes.

**Wireless.** This applies particularly to communications, i.e. wireless telegraphy and telephony and their applications, including D.F. but excluding Radar and other forms of radio. Wireless apparatus must not be carried in aircraft without a special licence. The licence is issued by the country to which the aircraft belongs.

**Wireless Operators' Licences.** Licences for wireless operators are of two kinds—

(a) Radio Telephony.

(b) Radio Telegraphy.

The latter licence includes telephony. Both of these licences are issued by the Postmaster-General on the recommendations of the Air Ministry. Applicants must be British subjects, and are required to pass an oral and practical examination. For the radio telegraphy licence ability to transmit and receive plain language messages at the rate of 20 w.p.m. is necessary.

**Women's Auxiliary Air Force.** In January, 1939, the Air Ministry undertook the responsibility for No. 20 R.A.F. (County of London) Company of the Auxiliary Territorial Service. On the 28th June, 1939, the W.A.A.F. was formed, with badges identical with those of the R.A.F. In the W.A.A.F. there is a great variety of R.A.F. trades, e.g. fitters, electricians, instrument repairers, balloon operators, drivers, etc. The force is administered by a special directorate in the Air Ministry.

**Women's Royal Air Force.** On 1st April, 1918, the women attached to the R.F.C. and the R.N.A.S. were grouped together as the W.R.A.F. The personnel were employed as carpenters, fabric workers, welders, dispatch riders, etc. They were disbanded in November, 1919.

**Wooden Propeller.** A propeller of kiln-dried, laminated hard wood.

**Work.** The product of a force

multiplied by the distance through which the force acts. The amount of work performed in overcoming a given resistance through a given space is independent of the time occupied in doing the work. Work is usually measured in foot pounds.

**Working Stress.** The stress which the members of a structure may possibly undergo.

**Wrist Pin.** The steel pin which attaches an articulated connecting-

rod to the master rod of an internal combustion engine.

**Wrist Pin End.** The crankpin end of an articulated connecting-rod of an internal combustion engine.

**Wrought Iron.** Wrought iron has a low carbon and manganese content, and has an average tensile strength of 40,000 to 50,000 lb. per sq. in. Wrought iron can be forged, and it is also capable of being welded.

## X

**X Engine.** An internal combustion engine which has its cylinders arranged in four rows. In end view the cylinders form an "X."

**"X" Licence (Ground Engineers).** The requirements for the award of the Ground Engineer's "X" Licence are laid down in the Air Navigation (Consolidation) Order of 1923. This licence is

issued to competent persons of either sex who are capable of the inspection of certain special equipment such as instruments, magneto overhaul and testing, parachute packing, etc. Licences are valid for one year at a fee of 21s. and may be renewed at a fee of 5s. on evidence of recent practical experience in the duties covered by the licence.



## Y

**Y Alloy.** An aluminium alloy which contains copper, nickel, magnesium, silicon, and iron. It responds to heat-treatment and retains its strength at engine working temperatures. It is used for pistons and small forged parts.

**Yaw Guy.** A cable which is led from the winch through blocks on the ground to the yaw guy wires of an aerostat.

**Yaw Guy Ropes.** Wire ropes which are necessary for the mooring and handling of an airship. They are dropped from the bow of an airship and are attached to the yaw guys on the ground.

**Yaw Meter.** An instrument for measuring the angle of yaw of an aircraft due to the relative wind.

**Yawing.** A movement of an aeroplane about the normal axis.

**Yawing Moment.** The moment due to the relative wind about the centre of gravity of an aeroplane which tends to turn the nose of the aeroplane to port or starboard.

**Yield Point.** The yield point of any material is the stress developed in the material when further deformation will continue without further increase of the applied stress.

**Yield Strength.** The stress which produces a definite permanent alteration in the shape of the material under test.

**Yielding.** The breaking, stretching, compression, or any alteration in shape of a material under stress.

**Young's Modulus.** See MODULUS OF ELASTICITY.

## Z

**Zap Wing Flap.** A special form of the split flap. It is connected to the wing in such a manner that it moves rearwards as it moves downward. An increase in lift is obtained by using this type of flap.

**Zenith.** That point in the heavens which is vertically overhead to an observer on the earth's surface.

**Zephyr.** A warm, westerly breeze which occurs in the Mediterranean.

**Zinc.** One of the chemical ele-

ments, symbol Zn. Atomic weight 65.4. It is used as a protective coating for sheet iron, the coating being applied by a process known as galvanizing.

**Zoom.** To climb for a short period of time at an angle which is greater than the normal climbing angle of the aeroplane. The extra energy required for this manoeuvre is obtained by diving and thus increasing the forward speed.

# DICTIONARY OF AERONAUTICAL TERMS

## APPENDIX A

### Aerodynamic Symbols

Acceleration due to gravity . . . . .	$g$	Lift . . . . .	$L$
Air speed, indicated . . . . .	$J$	Mass . . . . .	$m$
Angle of incidence . . . . .	$\alpha$	Power . . . . .	$P$
Angle of side-slip . . . . .	$\beta$	Pressure . . . . .	$p$
Angle of downwash . . . . .	$\epsilon$	Propeller diameter . . . . .	$D$
Area of main planes . . . . .	$S$	Propeller efficiency . . . . .	$\eta$
Aspect ratio . . . . .	$A$	Propeller pitch . . . . .	$H$
Chord length . . . . .	$c$	Propeller, rate of rotation . . . . .	$n$
Climb, rate of . . . . .	$V_c$	Reynolds' number . . . . .	$R$
Density . . . . .	$\rho$	Thrust . . . . .	$T$
Drag . . . . .	$D$	Torque . . . . .	$Q$
Engine revolutions per minute . . . . .	$N$	Viscosity, coefficient of . . . . .	$\mu$
Gliding angle . . . . .	$\gamma$	Weight . . . . .	$W$
Height . . . . .	$h$		

## APPENDIX B

### Scale of Visibility

No.	Description	Objects distinguishable at	Objects NOT distinguishable at
0	Dense fog . . . . .	Less than 50 metres	—
1	Thick fog . . . . .	50 m.	200 m.
2	Fog . . . . .	200 m.	500 m.
3	Moderate fog . . . . .	500 m.	1 km.
4	Mist or haze . . . . .	1 km.	2 km.
5	Poor visibility . . . . .	2 km.	4 km.
6	Moderate visibility . . . . .	4 km.	10 km.
7	Good visibility . . . . .	10 km.	20 km.
8	Very good visibility . . . . .	20 km.	50 km.
9	Excellent visibility . . . . .	More than 50 km.	—

# DICTIONARY OF AERONAUTICAL TERMS

## APPENDIX C

### The Beaufort Scale of Wind Force

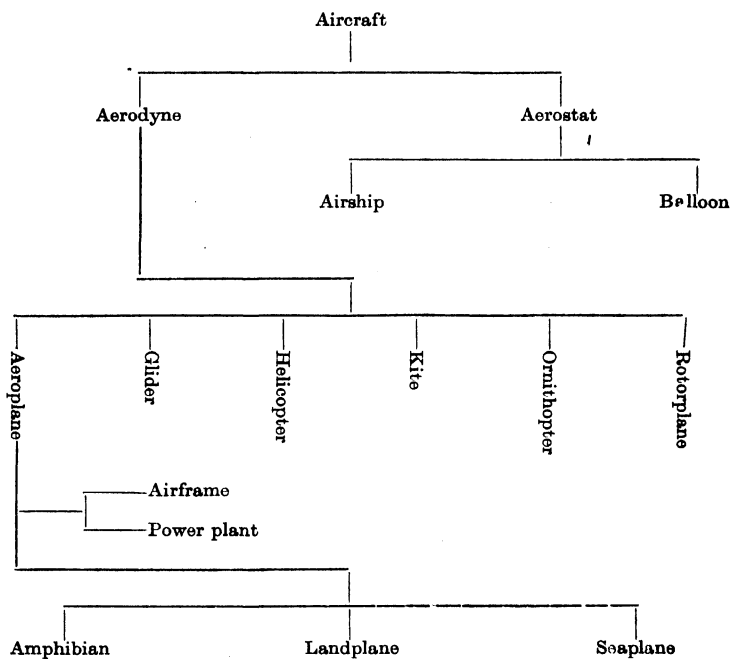
Beaufort No.	General Description of Wind	Specification of Beaufort Scale		Limits of velocity in miles per hour†
		For Coast use*	For use Inland	
0	Calm . . .	Calm . . . . .	Smoke rises vertically	Less than 1
1	Light air . . .	Fishing smack has steerage way	Wind direction shown by smoke drift but not by wind vanes	1-3
2	Light breeze . . .	Wind fills the sails of smacks, which then move at about 1-2 knots	Wind felt on face; leaves rustle; ordinary vane moved by wind . . .	4-7
3	Gentle breeze . . .	Smacks begin to heel and travel about 3-4 knots	Leaves and small twigs in constant motion; wind extends light flag . .	8-12
4	Moderate breeze	Good working breeze; smacks carry all canvas with good list	Raises dust and loose paper; small branches are moved . .	13-18
5	Fresh breeze . . .	Smacks shorten sail	Small trees in leaf begin to sway . . .	19-24
6	Strong breeze . . .	Smacks have double reef in main sail	Large branches in motion; whistling in telegraph wires	25-31
7†	Moderate gale . . .	Smacks at sea lie to	Whole trees in motion	32-38
8	Fresh gale . . .	All smacks make for harbour	Breaks twigs off trees; generally impedes progress . .	39-46
9	Strong gale . . .	—	Slight structural damage occurs; chimneys pots removed	47-54
10	Whole gale . . .	—	Trees uprooted; considerable structural damage . . .	55-63
11	Storm . . . . .	—	Very rarely experienced; widespread damage . . . . .	64-75
12	Hurricane . . .	—	—	Above 75

\* The fishing smack in this column may be taken as representing a trawler of average type and trim.

† Velocity at about 30 ft. above sea level.

‡ For statistical purposes force 7 is not considered as a gale.

# APPENDIX D



# DICTIONARY OF AERONAUTICAL TERMS

## APPENDIX E

### British-U.S.A. Nomenclature

#### *British*

#### *U.S.A.*

Accumulator	Battery
Air cleaner	Filter (air)
Aneroid	Capsule stack, pack
Ball and roller bearings	Anti-friction bearings
Bench test (under engine's own power, usually after overhaul)	Block test
Boost (usually measured in lb. per sq. in. gauge, i.e. above atmospheric pressure)	Manifold pressure (usually measured in inches ht. absolute)
Boost control unit	Manifold pressure regulator
Box spanner	Socket wrench
C-spanner	Spanner
Cheese head screw	Fillister head screw
Circlip	Lock ring
Collet	Split cone or wedge (on valve)
Control column	Control stick
Corrosion inhibitor	Slushing compound
Countersunk head screw	Flat head screw
Cup head screw	Round head screw
Earth	Ground (electrical)
Earthenware jar	Crook (used in heat-treatment)
Engine speed indicator	Tachometer
Exhaust pipe	Stack
Filter	Strainer (oil)
Filter	Screen (oil)
Fin	Vertical stabilizer
Fireproof bulkhead	Firewall
Flying controls	Surface controls
Fork joint or knuckle joint end	Clevis
Fret or score	Gall
Grub screw	Set-screw
Gudgeon pin	Piston pin
Label	Tag
Lb. or No.	#
Locking gear	Surface control lock
Locknut	Palnut
Main plane	Wing
Paraffin	Kerosene
Paraffin wax	Paraffin
Petrol (preferable to use "fuel")	Gasoline (gas)
Picketing rings	Mooring rings
Plain connecting-rod	Blade connecting-rod (used on multi-bank in-line engines)
Pressure head	Pitot tube
Ring nut	Spanner nut
Ring spanner	Box-end wrench
Ring spanner	Closed spanner wrench with internal lugs or surface lugs
Ring spanner	Spanner wrench
Running in	Green run
Set-screw or screw	Cap screw
Spigot	Pilot
Split pin	Cotter pin
Spring washer	Lock washer
Sump	Oil pan (use on in-line engines)
Tail plane	Horizontal stabilizer
Tail unit	Empennage
Test fan	Test club
Undercarriage	Landing gear
Vice	Vise



*Mosquito—the little heavy bomber.  
4,000 lb. to Berlin. There and back in 4 hours.*

## DE HAVILLAND ENTERPRISE

Every one of the many successful aircraft which de Havilland have contributed in thirty years of service to civil and military aviation has been the product of direct and independent contact with the user.

Every fresh branch of the de Havilland Empire-wide organisation—the engine and propeller divisions, the training and educational establishments, the overseas manufacturing and servicing units—has been the outcome of private initiative and broad, practical experience.



This comprehensive enterprise stands ready and equipped as never before to meet the needs of aviation in a new era

**DE HAVILLAND** *In the attack today—on the trade routes of the future.*

ANSON · BEAUFIGHTER · FLAMINGO · HAMPDEN

· HALIFAX · HURRICANE ·

LANCASTER · SPITFIRE · OXFORD · MOSQUITO

IN WAR  
AS IN PEACE

*Gillett Stephen  
& Company, Ltd.*

*Manufacturers  
of  
Aircraft Undercarriages  
and  
Hydraulic Equipment  
to the Industry*

ATLAS WORKS  
· BOOKHAM ·  
· SURREY ·

· STIRLING · TYPHOON ·



"SEAFOX"  
"BATTLE"  
"SWORDFISH"  
"ALBACORE"  
"FULMAR"  
"BARRACUDA"  
"FIREFLY"

1939 — 1945

9

NAMES—ALL SIGNIFYING  
MERITORIOUS SERVICE

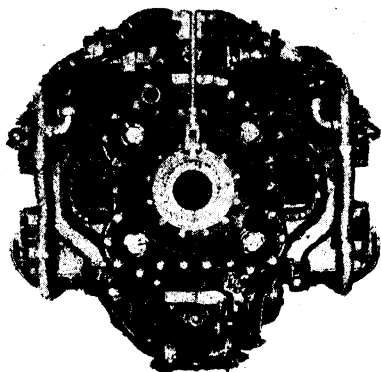
**FAIREY**

HIGH - PERFORMANCE  
SERVICE AIRCRAFT

THE FAIREY AVIATION COMPANY LTD HAYES MIDDLESEX



# NAPIER



## “SABRE”

STANDARD POWER UNIT IN  
BRITAIN'S LATEST FIGHTER AIRCRAFT

HAWKER  
“TEMPEST” AND “TYPHOON”

D. NAPIER & SON, LTD.  
LONDON  
W.3





















